PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.
OCT 8 1930

Vol. XXX, No. 7 *Whole No. 261*

OCTOBER, 1930

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Published by THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS
Publication Office: 404 N. WESLEY AVE., MOUNT MORRIS, ILLINOIS
Business Office: 1439 FOURTEENTH ST., MILWAUKEE, WISCONSIN
Editorial Office: 7633 CALUMET AVE., CHICAGO, ILLINOIS

Published monthly, October to June, Inclusive, at Mount Morris, Illinois *Price, $2.50 Per Year: 35 Cents Per Copy*
Entered as second-class matter March 1, 1913, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

Now Ready

Turtox Biology Catalog and Teachers Manual

1930-31 Edition

Written primarily for the high school teacher but also of interest to teachers in normal schools, colleges and universities. The new book contains 300 pages, over half of which are devoted to a teachers' manual and to chapters on laboratory and field work.

Free to Biology teachers and educational officials.

Ask For Your Copy

TURTOX PRODUCTS

The Sign of the Turtox Pledges Absolute Satisfaction

General Biological Supply House
(Incorporated)

761-763 East 69th Place

CHICAGO ILLINOIS

PROBLEMS IN GENERAL SCIENCE

By

HUNTER & WHITMAN

EACH UNIT begins with introductory questions and an interesting preview and is followed by self-testing exercises, achievement tests, fundamental concept tests, projects, practical problems, etc.

AMERICAN BOOK COMPANY

330 E. 22d Street, Chicago, Illinois

New York Cincinnati Chicago Boston Atlanta

SCHOOL SCIENCE AND MATHEMATICS is a cooperative enterprise. What are you doing to promote it? Send in a list of the names of your friends who should be subscribers to SCHOOL SCIENCE AND MATHEMATICS or, if you want to help more, send in their subscriptions.

CONTENTS *for* OCTOBER, 1930

No Numbers Published for
JULY, AUGUST AND SEPTEMBER

Contents of previous issues may be found in the Educational Index to Periodicals.

Trade with our advertisers. They will deal squarely with you.

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

Published Monthly except July, August and September,
at 404 N. Wesley Ave., Mount Morris, Ill.

Copyrighted 1930 by the Central Association of Science and Mathematics Teachers, Inc.

GLEN W. WARNER
EDITOR
7633 Calumet Ave., Chicago

W. F. ROECKER
BUSINESS MANAGER
1439 14th St., Milwaukee

DEPARTMENTAL EDITORS

Astronomy—George W. Myers
The University of Chicago

Botany—Worralo Whitney
5743 Dorchester Ave., Chicago

Chemistry—Frank B. Wade
Shortridge High School, Indianapolis, Ind.

Chemistry, Research in—B. S. Hopkins
The University of Illinois, Urbana, Ill.

Elementary Science—Harry A. Carpenter
West High School, Rochester, N. Y

General Biology—Jerome Isenbarger
Crane Junior College, Chicago

Geography—Katherine Ulrich
Oak Park—River Forest Tp. High School, Oak Park, Ill.

General Science—Ira C. Davis
The University High School, Madison, Wis.

Mathematics—Jacob M. Kinney
Crane Junior College, Chicago
—Chas. A. Stone
The University of Chicago

Mathematics Problems—C. N. Mills
Illinois State Normal University, Normal, Ill.

Physics—Homer LeSourd
Milton Academy, Milton, Mass.

Physics, Research in—Duane Roller
The State University of Oklahoma, at Norman, Representing American Physical Society

Science Questions—Franklin T. Jones
Equitable Life Assurance Society of the U. S Cleveland, Ohio

Zoology—Joel W. Hadley
Shortridge High School, Indianapolis, Ind.

PRICE. The subscription price is Two Dollars and Fifty Cents a year; Canada **$2.75**; foreign countries $3.00; single copies 35 cents.

ALL REMITTANCES should be made payable to the order of **School Science and Mathematics and mailed to the Business Manager. Remittances should be made by Post Office Money Order, Express Order, or Bank Draft.** If personal checks are sent, please add five cents for collection.

CHANGE OF ADDRESS. Subscribers should send notice of any change of address to the Business Manager before the 12th of each month; otherwise they are held responsible for magazine sent to their former address, and no duplicate copies will be sent except on payment of 35 cents for each copy.

MISSING NUMBERS will be replaced *free* only when claim is made within thirty days after receipt of the number following.

BACK NUMBERS can be obtained from the Business Manager at 40c (or more) per issue depending on the date of issue and the supply. Write for quotation.

REPRINTS, if desired, must be ordered in advance of publication. Reprints of leading articles will be printed as ordered, the actual cost (with cover, if desired) to be paid for by the author.

MANUSCRIPTS. Contributions on Science and Mathematics Teaching are invited. Articles must be written on one side of the sheet only. All illustrations must be drawn or written in jet black on a separate sheet of manuscript. Contributors are requested to write scientific and proper names with particular care. Manuscripts should be sent to the Editor of **School Science and Mathematics, 7633 Calumet Ave., Chicago,** or to the proper departmental Editor. Books and pamphlets for review should be sent to the Editor.

Entered as Second-Class Matter March 1, 1913, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

SCHOOL SCIENCE AND MATHEMATICS

VOL. XXX No. 7 OCTOBER, 1930 WHOLE No. 261

EDITORIAL RESPONSIBILITY.

The editor of a book, especially one that is to be used as a text or reference book, or of an educational journal, holds a position of responsibility to the members of the profession. The readers of the publication have a right to demand precision in statements of facts, correct terminology, mechanical accuracy, and proper recognition for previous work. Errors and ambiguous sentences frequently cause serious difficulties in teaching. Some very unfortunate examples of careless editing have appeared in science textbooks but more startling are some that have appeared in standardized tests. These cases naturally lead us to question the value of the standards set, and frequently cause unjust criticism of the entire process. Perfection may not be possible but gross errors should be eliminated before educational material is turned out for school use.

In making these criticisms SCHOOL SCIENCE AND MATHEMATICS does not claim sanctity. All possible care is exercised to prevent errors and constructive criticism is solicited. Contributors are urged to prepare articles so as to leave no doubt as to the meaning. Figures and mathematical characters should be given unusual attention. Sources of information should be duly credited. Contributors should always read the proof carefully and make all corrections clear. It is surely proper to assume that the author knows more about the details of his contribution than the editor and should be just as anxious that the finished product will be perfect.

In one respect a publication is sometimes misunder-

stood. Usually not all ideas published are approved by the editorial staff. The editors of SCHOOL SCIENCE AND MATHEMATICS do not agree with all articles published nor endorse all the recommendations made. Discussion is one of the best means of clarifying ideas. An article presenting one side of a controversial topic will be published whether it is in agreement with the opinion of the editorial staff or not. Even an article discussing a method of teaching or a classroom device may appear altho the editors consider it unpedagogical, non-scientific or obsolete, if there is good reason to believe that it may stimulate thought and discussion and thus be helpful without doing serious injury. Our aim is to help, to stimulate, to encourage, to inspire. We do not want to think for you; we have no pet theory to propose, no selfish doctrine to sponsor, no set dogma to promote.

REPORTS OF RESEARCH STUDIES.

The aim of SCHOOL SCIENCE AND MATHEMATICS is to promote teaching; to assist the teacher in solving teaching problems. It is a journal for teachers. Reports of research studies both in teaching and in subject matter help to accomplish this aim. In general the teacher's use of such reports differs from the use made by investigators. The teacher wants to know (1) what was studied, (2) what was found out, (3) how the study and the findings may be used to improve his efficiency. He has no time for minute details and in many cases he cannot take time for a critical examination of the method used nor of the results obtained. Like the ordinary investor, the teacher must rely on the reputation of the house he patronizes. On the other hand the investigator should make a critical examination of the details of the problem. He wants to know (1) what was studied; (2) the method used—how the problem was attacked, how the data were collected and treated, what use was made of similar or related studies, what difficulties were encountered and how they were overcome, what subsidiary items were neglected or disregarded; (3) what conclusions were drawn or results obtained.

These two quite different uses for reports demand two types of report. First, a limited number of copies of the

detailed discussion of the study should be available for the use of investigators; second, an abstract with reference to the detailed report should be published in educational journals that reach large numbers of interested readers. Articles of the latter type are solicited by SCHOOL SCIENCE AND MATHEMATICS. Investigators are requested to send us abstracts of their studies prepared for the use of classroom teachers. If you are doing research work on the curriculum, in testing, in methods of teaching, on the use of teaching techniques and devices, etc., send us your report. If you have designed a new piece of apparatus or modified and improved an old piece or process; if you have developed a new proof, discovered new evidence, or have a new theory to propose, tell us about it.

BOTANISTS! ATTENTION!

By WORRALLO WHITNEY, *Botany Editor.*

This Journal has been receiving relatively few papers for publication from botanists for a long time. There has been a recrudescence of interest in biology resulting in quite a grist of papers on that subject and its place in the secondary school curriculum. But why the dearth of papers on botanical topics with a much wider field to draw upon? Are there no botanists doing research work in the field of botany? Is the course of study for botany so standardized, so satisfactorily fixed, that there is no room for more experimentation? Are botany teachers doing no thinking? We can not believe that this is the answer to the question. Why are there not more papers on this subject? It is true that problems arising in botany or any natural history subject have not the fixed limits to be found in the problems of the physical sciences and mathematics. But there are plenty of unsolved problems in botany. We believe there is room for study and experimentation on the course of study, toward making it more flexible and better adapted to meet the needs of schools with widely varying constituencies.

If you are doing some studying and thinking—whether in research or in developing a different attack for teaching some part of the course in botany, why not let the

Journal and thereby other teachers know about it by writing it up in the form of a paper? Surely others will be interested to know what you are doing even if they cannot put it into use. Below we append a list of suggestive topics which may help you to decide whether you have something to offer.

1. Are you studying some ecological problem in botany? Anything in Systematic botany? Have you any results to report?

2. Do you encourage your pupils to undertake projects in botany? If so what and how?

3. Do you make any special effort to make your course in botany "practical"? If so, how?

4. What do you do with the algae? Fungi? Liverworts? Ferns? If different from the usual course, what and how?

5. Do you do any "practical" work with the fungi?

6. What are you doing with bacteria—anything special? With Sanitation?

7. How do you teach plant breeding? Inheritance? Mendel's work?

8. Do you do anything special with forestry? Conservation of forests?

9. What about soils with relation to fertility? How soils may be improved? Impoverished?

10. Field work? Do you have any method for promoting individual field work on the part of your students?

11. How do you encourage your students to learn the wild flowers in the field? What about the conservation of the wild flowers?

PORTRAIT OF A GREAT TEACHER.

First, whatever the ideal teacher may be teaching, it will be for him a window through which he looks out upon the whole universe.

Second, the mere merchandising of information will never seem to the ideal teacher his main purpose; the kindling of the will, the enrichment of the emotions, the lighting up of the imagination, the making of students sensitive and eager will seem to him more important than all else.

Third, the ideal teacher will have a gay and gracious spirit, first, because he conceives teaching as a great and exhilarating enterprise and second, because he has trained himself so that he approaches his task with a sense of confidence and effectiveness.—Glenn Frank, Wisconsin University.

THE USE OF THE PROJECTION MICROSCOPE IN THE TEACHING OF BIOLOGY[1].

BY N. HENRY BLACK,

Harvard University, Cambridge, Mass.

While visiting the Deutsches Museum in Munich three years ago, I found a very excellent library of recent scientific books. Among these I found one which deserves to be better known: "Die Mikroprojektion im Unterricht" by F. P. Wimmer, published by E. A. Seeman at Leipzig in 1926. Through the book I came to know the author and his remarkable work in developing the use of the projection microscope in teaching biology in the schools of Munich.

A GERMAN CLASSROOM FOR BIOLOGY.

In the first place, I found that the rooms which were used as biology classrooms were provided with black window shades which could easily be closed to make the room absolutely dark. Furthermore, instead of a large roll screen or a wall surface, they were using for their projection work a cardboard screen about 1 meter square mounted on a

FIG. 1. A BIOLOGY CLASSROOM IN MUNICH WITH A PORTABLE SCREEN FOR MICROPROJECTION. WINDOWS PROVIDED WITH DARK SHADES.

[1]Summary of an illustrated talk given on December 7, 1929, before the New England Piology Teachers at the Jefferson Physical Laboratory.

movable stand. This screen was ruled in 25 squares as shown in figure 1. Every row of students' desks and benches was raised about 4 inches higher than the one in

FIG. 2. PROJECTION MICROSCOPE IN USE, THE WHOLE CLASS DRAWING.

front of it (Fig. 2) and finally, desks accommodating 4 students in a row were illuminated by small individual lamps, which did not give much general illumination in the room but did furnish enough light so that each student could draw in his notebook what he saw projected on the screen (Fig. 3).

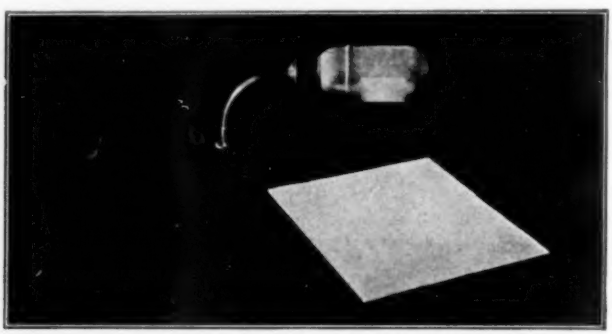


FIG. 3. A DESK LAMP FOR EACH STUDENT.

MICROPROJECTION APPARATUS.

In the back of the room, on a swinging shelf, was placed the projection microscope (Fig. 4). This was made up of commercial parts and was based on the design of Professor Köhler of Jena. Let us examine the apparatus in a little

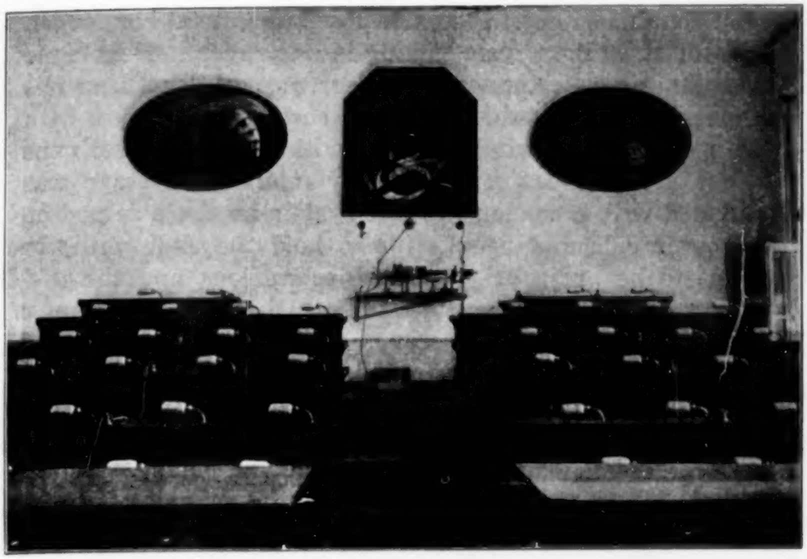


FIG. 4. THE REAR OF A BIOLOGY CLASS ROOM, SHOWING THE PROJECTION MICROSCOPE.

more detail. The source of light was a small right-angled arc-lamp using about 5 amperes of direct current. The upper horizontal carbon (about 5 mm. in diameter) was the positive electrode, and its crater furnished a very bright

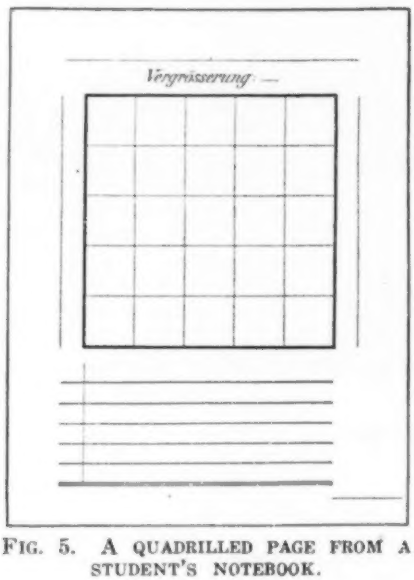


FIG. 5. A QUADRILLED PAGE FROM A STUDENT'S NOTEBOOK.

point source of light. It was enclosed in a metal box, which kept the stray light from leaking into the room. Next came an aplanatic collector, or condenser, provided with an iris diaphragm. After this came the cooling cell, a box with two parallel glass windows filled with water to absorb the longer heat waves. The ordinary microscopic stage was provided with a condensing lens system on one side and on the other side and usual clips to hold the slide with the object to be projected. The objective lens and the eye-piece were mounted in a tube and attached to a stand much as in the ordinary microscope. This stand was supplied with a micrometer screw for fine adjustment. The entire collection of apparatus was mounted on a horizontal optical bench and seemed to serve the purpose very well.

Each student had in his own notebook a small replica of the quadrilled ruled screen such as is shown in figure 5. Some of the drawings, figure 6 for example, seemed to me

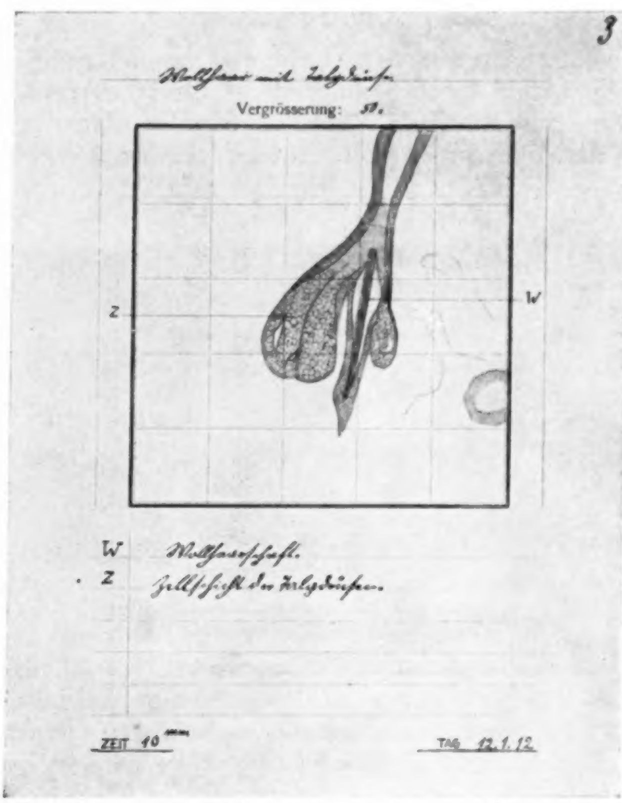


FIG. 6. A STUDENT'S DRAWING MADE IN 10 MINUTES.

to be unusually well done. This one, by the way, was made in 10 minutes, a surprisingly short time. All members of the class could be drawing at the same time and the teacher could be sure that they were all seeing the same thing. This is the outstanding advantage of Dr. Wimmer's method of procedure.

A HOME-MADE PROJECTION OUTFIT.

At once the question came to me, can we not in this country use more extensively the projection microscope, for it evidently is a great time saver? Every biology teacher knows that it takes unlimited patience and "elbow teaching" in the laboratory to make sure that each member of a class of 25 or 30 pupils uses properly his compound microscope and sees what is intended to be observed. My own first attempt at improvising a projection microscope

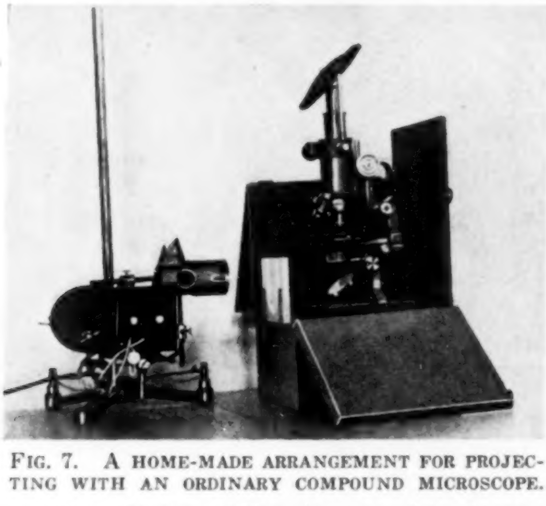


FIG. 7. A HOME-MADE ARRANGEMENT FOR PROJECTING WITH AN ORDINARY COMPOUND MICROSCOPE.

was suggested by Krüss of Hamburg and is shown in figure 7. It consists of a small arc lamp[2] with right-angled carbons using about 5 amperes on a direct-current line. Next comes the condensing lens and then the small water cell.[3] Then follows the wooden box, which was built by the carpenter so that its sides can be opened down for adjustment. This box furnishes a stand and a light shield for the compound microscope. The light from the arc lamp is focussed

[2]This lamp is supplied by E. Leitz, Inc., 60 East 10th St., New York City.
[3]This cell was supplied by the Central Scientific Co., 460 East Ohio St., Chicago.

on the mirror below the stage and is reflected directly up through the condenser on to the object. The ordinary microscopic objectives and eyepiece are then attached, and we use, of course, only the low power, especially for the eyepiece. To the top of the eyepiece is attached a mirror, as shown in the figure, or a right-angle prism to throw the image directly on a vertical cardboard screen perhaps 10 feet away. This arrangement is, of course, not quite so good as that used in the Munich schools which has already been described. Whenever we introduce a mirror to change the direction of the light (which is here done twice) we sacrifice some of its intensity.

FIG. 8. A SIMPLE LEITZ PROJECTION MICROSCOPE USING A 6-VOLT BULB.

SOME PRACTICAL PROJECTION MICROSCOPES.

Another form which is simpler to operate and works very satisfactorily up to perhaps 200 diameters is the Leitz simple projection microscope (Fig. 8), which is made in Germany but is on the market in this country. This apparatus consists of a very small incandescent 6-volt lamp such as would be used in an automobile headlight, a condensing lens, the stage with the object, and finally the objective lens system, which is built in two parts so that one can quickly change from low to high power. Notice that in this apparatus there is no cooling cell and no eyepiece; that, of course, is a saving in expense and also makes greater illumination possible. This piece of apparatus can, by the aid of a mirror attached to the objective, be used in a vertical position when a slide containing an object in liquid must be examined in a horizontal position. It can also be used for

drawing objects in a notebook. Since the incandescent lamp is not so powerful as the arc lamp, it is, of course, necessary that the room be absolutely dark.

Another form of apparatus very similar to this is that shown in figure 9, made by Seibert of Wetzlar, Germany,

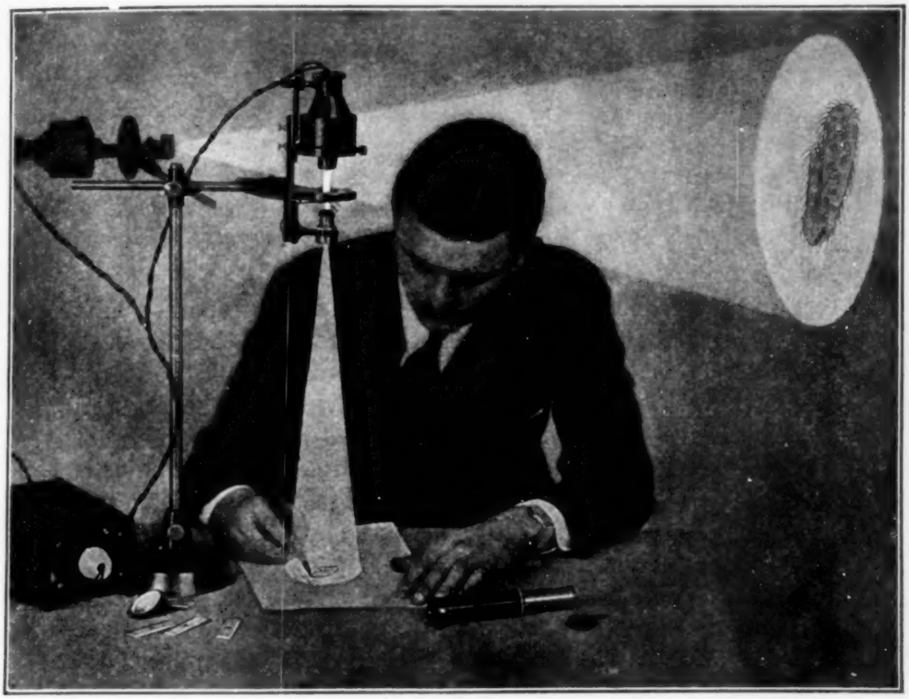


FIG. 9. A SIMPLE PROJECTION MICROSCOPE USING A 12-VOLT BULB (SEIBERT).

and sold in this country by the Clay-Adams Company.[4] The principal advantage which this apparatus has over the Leitz form is that it can be easily converted into the ordinary compound microscope. A still better form where the direct current, 110 volts, is available is the regular microprojection apparatus manufactured by Leitz. This consists of the 5-ampere arc lamp operated by clock work and contains the usual condensing system with water cell for cooling. The apparatus (Fig. 10) looks very much like the ordinary compound microscope turned into a horizontal position, and gives very much better illumination and higher magnification than the simpler form using the incandescent lamp.

[4]Clay-Adams Company, Inc., is located at 117 East 24th Street, New York City.

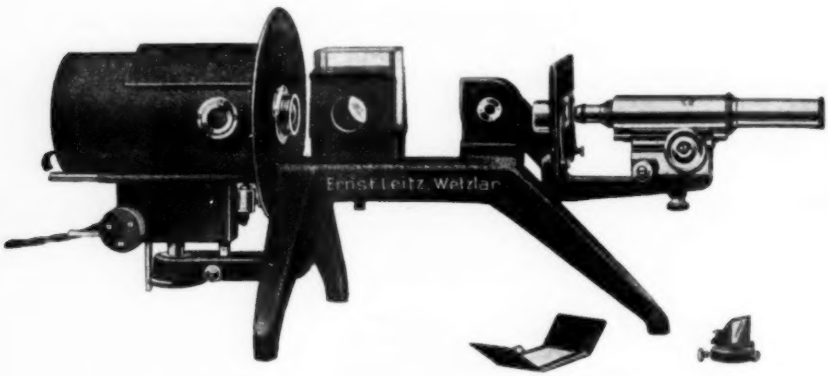


FIG. 10. A 5-AMPERE DIRECT-CURRENT ARC-LAMP PROJECTION MICROSCOPE (LEITZ).

For those schools and colleges which can afford a really good optical bench and optical equipment in the physical sciences, I would strongly urge the purchase of the Zeiss apparatus[5] shown in figure 11. Here we have the regular 5-ampere arc-lamp, which is controlled by clockwork, the aplanatic collector for condensing the light, the cooling cell, and the condenser underneath the object stage; then the tube containing the objective lens at one end and the eye-piece in the other. In all this optical projection work it is absolutely essential that every part should be in perfect alignment. This is most simply done on the Zeiss optical bench, a triangular piece of cast iron carefully planed, to which as a base all parts may be attached quickly and easily.

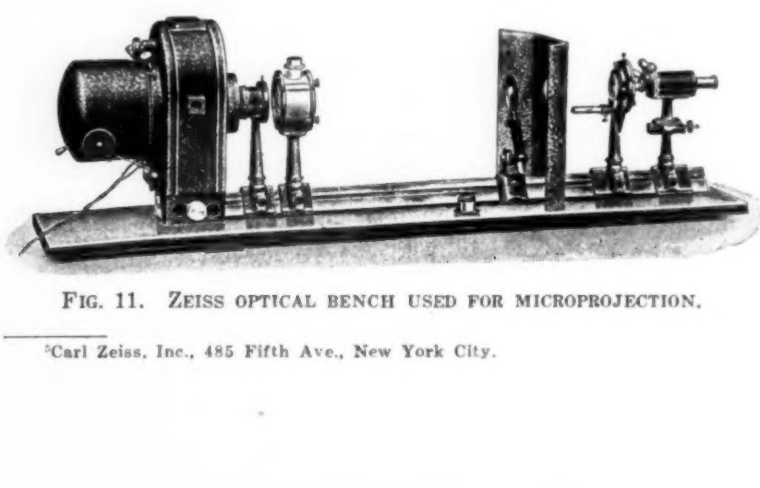


FIG. 11. ZEISS OPTICAL BENCH USED FOR MICROPROJECTION.

[5]Carl Zeiss, Inc., 485 Fifth Ave., New York City.

Why Use Microprojection?

The reasons for urging the more extensive use of the microprojection equipment can be summarized as follows. It makes it possible for the biology teacher to show a microscopic object to the whole class at the same time and to be sure that they have their attention focussed on the really important things. After all, if a student studies biology for only one year it seems a needless expenditure of time to teach the technique of using the compound microscope. If he is going on in biology, this is absolutely necessary and therefore is commendable; but in our general courses it would seem that we might better show the results of the use of the microscope. From my examination of schools, I should say that the greatest handicap today in the use of this apparatus is the difficulty in really, quickly, and efficiently darkening the room. If small lamps are attached to the desks, the darkness of the room will not seriously interfere with the discipline and the students will be able to see and to draw what is projected. Busy, interested students do not get into mischief. Even the physics teacher, it seems to me, might very well spend a little less time on the optical system of the compound microscope and a little more time on the use of the compound microscope in medicine, in mineralogy, in chemistry, and in general as a machine for research in the field of the very small.[4]

Some Practical Hints About Operating the Projection Microscope.

1. In using the projection microscope always begin with the low power to show the relation of the parts and then use the higher power to show details.

2. Use objectives without any eyepiece for low power.

3. Use, if possible, a screen distance from 10 to 25 feet. Use the shorter distance for the high magnification.

4. Make the room dark and use a perfectly white opaque screen.

5. In connecting the arc-lamp to the service line, insert a suitable rheostat in the line to control the current (about 5 amperes).

---

[4]Let me recommend an excellent little book in the Henry Holt and Co. Home University Library series entitled: "Microscopy in the Service of Man" by Robert M. Neill.

6. The tip of the horizontal carbon when made the positive electrode will glow very intensely.

7. Always use a water-cell with the arc as a source of light.

8. Remember that the intensity of illumination is just as important as the magnification of the image.

9. It is of the utmost importance that every part of the apparatus be accurately centered and that the parts be separated from one another the right distance.

10. One can do excellent microprojection with home-assembled apparatus. But have everything in perfect order and adjustment whenever an exhibition of microscopic objects is to be made.

INLAND SEA ONCE COVERED BLACK HILLS.

The Black Hills of South Dakota and Wyoming stand conspicuously above the lowlands that surround them. Yet the adjoining portions of these lowlands are in a sense part of the Black Hills, for the rocks of which they are made are remnants of extensive beds that were bent up steeply around the uplift. These beds, being soft, have been in large part washed away by streams, whereas the limestones, granites, and other hard rocks in the central area, being much less easily eroded, have been in greater part left to form the present Black Hills.

Long before the Black Hills or any of the near-by Rocky Mountains were uplifted, the soft rocks of the lowlands were laid down as fine muds, nearly a mile thick, in the last of the many great inland seas which from time to time have spread widely over North America. The fine muds were later somewhat hardened by deep burial under other muds and by bending at the time of uplift, and they now form rocks that are made up largely of clay, sand, lime, and fossil remains of animals and plants. Although very fine grained and consequently difficult to study, these rocks still record a complex history, which the geologist attempts to decipher.

A paper entitled "Lithologic studies of fine-grained Upper Cretaceous sedimentary rocks of the Black Hills region," recently issued by the Department of the Interior as Geological Survey Professional Paper 165-A, not only describes the methods of studying these kinds of rocks but also presents many conclusions about their complex history. The rocks were originally very similar to the so-called blue muds now accumulating near present oceanic coasts, and the oil found in several oil fields in northeastern Wyoming may have come from the remains of sea-living organisms that were entombed in the accumulating muds of this region. The rocks are thinly layered much like sheaves of paper, and each thin layer appears to represent the mud deposits of a single year. If this is so, the inland sea in which the muds accumulated covered the site of the present Black Hills for not less than 5,000,000 and possibly many millions of years.—Department of the Interior.

ELEMENTARY MATHEMATICS IN COLLEGES.

By DR. WILLIAM E. ROTH,
Assistant Professor of Mathematics, University of Wisconsin, Extension Division, Milwaukee, Wis.

Mathematicians are prone to disregard the utility of the subjects they like most to study and to teach, moreover they do not like to justify their pet subject on practical grounds. The students in colleges, on the other hand, want some definite knowledge of the utility of courses they are obliged to take; likewise educators upon whom the responsibility of preparing young people for life rests must feel convinced that a knowledge of required courses has either a cultural or a practical value in life. For mathematics we shall here emphasize the utilitarian value, though we do not doubt that a subject which touches so many fields of thought has likewise great cultural value.

Mathematics is a powerful tool for the research man in any science and for the engineer; it is as much a means of understanding scientific and technical subjects as it is an aid in applying the knowledge of them. Therefore, we sometimes find successful men in these fields who rarely use the advanced mathematics which they had learned in college, but who in acquiring their knowledge needed it to master the principles they must constantly apply in their work. Without calculus it is impossible to study and to understand dynamics—the science of motion. Thus the student will meet with calculus in hydrodynamics, electrodynamics, aerodynamics, in the dynamics of the electron and of the solar system. Calculus is the mathematics of motion; in fact, it was through his studies of effects of forces in a moving system that Newton was led to discover, or if you please, to create this eminently potent branch of mathematics. But calculus is equally effective in the study of statics, that is, of forces in equilibrium or at rest. Thus torques and strains of beams, bending moments, moments of inertia, pressure of fluids, work, power, potential, the curve of and the forces acting upon the cable sustaining a suspension bridge and the pressure exerted upon members of an arch may be computed from appropriate algebraic formulae that are solutions of surprisingly simple differential equations. The prospector now relies on electrical, magnetic, and seismographic methods to aid him in

locating valuable mineral deposits and these methods are based on mathematical considerations that can be understood only when one is conversant with calculus. The items we have mentioned, though the list is not comprehensive, touch nearly every branch of engineering and are therefore indicative of the importance of calculus in that field.

The examples of the applications of mathematics that we have cited are taken almost exclusively from the domain of physics so that we have already indicated the significant role of calculus in this study. Modern physical research has long out-stripped the bare mathematical needs of the engineer. Indeed physicists are crowding mathematicians in their eagerness to grasp new mathematical knowledge and are themselves making mathematical discoveries, hoping by means of this new knowledge to discover new facts about the physical world. The powerful aid of mathematics to physics has been indicated above only in its most elementary aspects; in regard to its more profound applications in that field A. W. Stern says: *"The tendency of this new physics is to operate with mathematical symbols and not with physical ideas and concepts derived from sense experience."*[1] That this will probably be the case is further emphasized by the chemist, Irving Langmuir, who, in giving the presidential address before the American Chemical Society (Sept. 1929) said: *"We have no guarantee whatever that nature is so constructed that it can be adequately described in terms of mechanical or electrical models; it is much more probable that our most fundamental relationships can only be expressed mathematically if at all."*[2] Whether or not these opinions will be borne out by the experience of time, it is nevertheless probably true that the modern physical theories, however irrational they may appear, cannot be broken down nor improved by one who does not understand their mathematical foundations; therefore he, who wishes to aid in the accomplishment of such ends, cannot follow a wiser course than to prepare himself in mathematics.

Now, as is well known, chemistry studies the changes of matter and so likewise does biology; hence calculus, the

[1]Stern, A. W., The Role of Mathematics in Modern Physical Theory, *Monist.*, Vol. 39 (April, 1929), pp. 263-272.
[2]Langmuir, Irving, Modern Concepts in Physics and Their Relation to Chemistry, *Journal of the American Chemical Society*, Vol. 51 (1929), pp. 2847-2868.

mathematics of motion, should aid in the study and in the investigation of these subjects. To show that this is really the case we shall quote men whose interest is not that of teaching and studying mathematics but is that of furthering the advance of these sciences. Thus Farrington Daniels says: "*Chemistry has graduated from the class of descriptive sciences into the class of exact sciences and has taken its place by the side of physics and engineering as a branch of mathematics. All chemical phenomena and many biological phenomena are now being interpreted in terms of physical chemistry, and physical chemistry cannot be mastered without a foundation in mathematics which extends through calculus. Research chemists are keen to realize their dependence on mathematics and many of them feel blocked in their progress by their weakness in mathematics.*"[3] H. L. Adams in his address upon retiring from the Presidency of the Washington Chemical Society said: "*Actually the amount of pure mathematics required in most branches of chemistry is small. Elementary calculus is as far as most need go—.*" and again, "*The internal structure of the atom is no longer a complete mystery. The physicists have apparently claimed this territory for their own and it must be admitted that the great fundamental discoveries in this field have been made by physicists. Their remarkable progress has been largely due to the fact that they did not fail to use all possible mathematical tools including the most profound analytical methods.*"[4] That the study of atomic structure might be taken out of the chemist's hands was foreseen by A. Crum Brown for we find that nearly forty years ago he made the prediction: "*But unless he* (the young chemist) *learns the language of the empire* (of mathematics), *he will become a provincial, and the higher branches of chemical work, those which require reason as well as skill, will gradually pass out of his hands. Let them while there is time learn the language of the empire. Let them become fluent and ready in its use; let them read with care the work that is being done on the border between chemistry and mathematical physics, and, as they find opportunity, do such work themselves, and so be ready to take*

[3] Daniels, Farrington, Mathematics for Students in Chemistry, *American Mathematical Monthly*, Vol. 35 (1928), pp. 3-9.

[4] Adams, H., Chemistry As a Branch of Mathematics, *Journal of the Washington Academy of Sciences*, Vol. 16 (1926), pp. 266-276.

their part in the union which will certainly come."[5] The outcome as Professor Brown predicted it has in a measure come to pass; fortune smiled on the physicists, partly because they were quick to accept mathematics as an aid in their research and partly because the discovery of X-rays and radio-activity, which initiated the recent advances in physics, were regarded as physical and not chemical phenomena. The shortcomings in the past are being rapidly corrected, chemists are beginning to speak fluently the language of mathematics and no one who wishes to enter their fundamental field can afford to neglect learning the language in which its affairs are so largely conducted.

An interesting article by O. W. Richard on "The Mathematics of Biology" cites several very significant applications that have been found for mathematics in that science. We quote the following excerpts from Richard's paper: "*—anyone who even idly turns the pages of the Journal of General Physiology must be forcibly reminded of his calculus text. Until recently one could read by omitting the mathematics. Now, however, it is necessary to follow the mathematics in order to understand the logic because this form of expression permits the presentation of such information in a more concise manner.*" Again he says, "*With the present increase of mathematical usage in experimental literature even the medical student must be familiar with the more general facts of calculus and biometrics.*"[6] And more recently Harris said, "*The tendency of the times is unmistakable; the demand for quantitative work is more and more dominant in the biology of today,*" and "*That a man should be able to reason about highly complicated phenomena without the use of mathematical formulae is no more remarkable than that he should be unable to see chromosomes without the microscope.*"[7] The quotations, taken as they are, from the writings of men who are not primarily interested in mathematics, are very significant as an indication of the esteem in which scientists hold the subject.

---

[5]Brown, A. Crum, Presidential Address, *Transaction of the Chemical Society* (London), Vol. 61 (1892), p. 478.

[6]Richards, O. W., The Mathematics of Biology, *American Mathematical Monthly*, Vol. 32 (1925), pp. 30-36.

[7]Harris, J. A., Mathematics in Biology, *The Scientific Monthly* (August, 1929), pp. 141-152.

The frequency with which we are obliged to refer to calculus and the importance of the connections in which the references occurred must cause us to agree with Thomas Hill, a former president of Harvard University when he said that: *"The discoveries of Newton have done more for England and for the race than has been done by whole dynasties of British monarchs."*[8] For Newton's greatest discovery and the one that made the others possible was calculus.

The exposition of the utility of mathematics that has been presented thus far is concerned primarily with calculus. Consequently the reasons that algebra, trigonometry, and analytic geometry ought to be required of college students must still be discussed. One of the principal reasons for the requirement is that these courses are the stepping stones to calculus. Newton and Leibnitz could not have discovered, or, as some prefer to say, created calculus without the analytic geometry of Descartes, for its logic is too subtle to be appreciated without the aid of the pictures that this geometry gives, and we now cannot master the subject without the same aid. Again analytic geometry is based on algebra and trigonometry. Hence, these three subjects, algebra, trigonometry, and analytic geometry, are certainly useful then for those who will need calculus in their profession.

If, however, one is not interested in the sciences nor in the engineering profession, he should, in order that he may become an intelligent and learned man, gain a substantial knowledge of mathematics. Thinkers in all fields of human endeavor and progress must concern themselves with its pure logic and with its universal utility. *"Who does not know mathematics and the results of recent scientific investigation dies without knowing truth."*[9] And the philosopher Hegel said, *"Whoever does not know the works of the ancients has lived without knowing beauty."*[10] But in the sciences only the mathematics and the philosophy, if philosophy is a science, of the ancients are entirely valid today. Their mathematics is now studied as arithmetic, algebra, and geometry. It is a simple matter to find many words of

---

[8]Hill, Thomas, The Imagination in Mathematics, *North American Review*, Vol. 85 (1857), pp. 223-237.

[9]Shellbach, [10]Hegel, quoted by J. W. A. Young, *Teaching of Mathematics* (N. Y., 1907), p. 44.

praise of mathematics as cultural background though some refute such a claim for the subject. Florian Cajori, in *Mathematics in Liberal Education*[11] has given a rather complete collection of opinions on this aspect of the subject. A careful perusal of this book indicates that the following opinion as expressed by Biertholot will summarize the feelings that mathematics has quite generally inspired: "*Mathematics gives the young man a clear idea of demonstration and habituates him to form long trains of thought and reasoning methodically connected and sustained by a final certainty of results; and it has the further advantage, from a purely moral point of view, of inspiring an absolute and fanatical respect for the truth.*"[12]

There is now growing up a new appreciation of the cultural value of mathematics which arises out of recent developments in philosophy. This new attitude finds expression in the works of Bertrand Russell, A. N. Whitehead, Cassius Keyser, and of the Dutch philosopher Brouwer; its outcome and the part mathematical thinking will play in philosophy is a matter of conjecture for the present. These idealized statements cover muted ground and consequently are convincing only to him who agrees with them. We shall, therefore, seek to show in what respects aside from possible cultural value, algebra, trigonometry, and analytic geometry deserve important places in a course of study.

For algebra, in itself, we can give no more utilitarian reason for its study than we have already given; namely, that it is the main trunk supporting the higher branches of mathematics mentioned and as the foundation upon which the mathematics of investments, and the mathematics of statistics and economics rest. These certainly leave no doubt as to utility. To be more specific we will mention only the fact that the computation of sinking funds, annuities, depreciation, value of bonds, and of insurance are all based on formulae whose derivation requires algebra and which can be used intelligently only when their algebraic derivations are understood. The theory of probability, a subject that is receiving more and more space in college algebra textbooks, has long been very useful as a sound

[11]Cajori, Florian, *Mathematics in Liberal Education*, Christopher Publishing House, Boston (1928).

[12]Biertholot, M. P., Science As an Instrument in Liberal Education, *Popular Science Monthly*, Vol. 51 (1897), p. 253.

foundation for life insurance, and is now proving an indispensable aid in biological research and in sociology. Moreover, physics and astronomy present problems in which the number of unknown factors makes their separate treatment impossible, but the probable aggregate effect of these factors can be determined with a fair degree of certainty.

Trigonometry certainly is useful to the surveyor, to the engineer, to the navigator of the sea and of the air, and to the men in some other walks of life. For the man of science the most interesting and useful contribution of trigonometry is the trigonometric functions, particularly the sine and the cosine of an angle. One sees these functions in the ripples on the surface of a pond; one hears them in music; and by means of them the radio is enabled to bring us entertainment and knowledge; and it is they that play a very important role in calculus and its applications. Analytic geometry is of little use in itself and becomes useful only as an approach to other branches of mathematics, particularly to calculus, and can have very fundamental utility in life only for him who wishes to pursue mathematics further.

We have said nothing regarding mathematics as a field of research. Work here has, in the past, been carried on largely by teachers in colleges and universities and it is desirable that this should continue to be the case in the future. However, large industrial enterprises are beginning to feel the need of men trained in applied mathematics who can aid in industrial research. The number of such positions will probably increase and the investigations that are carried on by men holding them will gradually grow in importance. Nevertheless, research work in mathematics which may have no immediate use in the arts must be carried on by teachers in colleges and universities. Whether it be as a teacher or as a technician that one takes up the study of advanced mathematics, he will find an immense field of research awaiting him. Very little is known when compared with that which is still unknown. All fields of mathematical investigation contain many buried treasures that await someone to uncover them. Some fields that were once thought to have been completely worked out have since disclosed much precious material and consequently the existence of material that cannot now be imagined is very probable. We may mention two problems from the theory

of numbers to show how limited the knowledge of mathematics really is; and these will not be taken because of their importance either practically or theoretically, but because they can be stated in the language of arithmetic and algebra. The first is to find (by analytical methods) the next succeeding prime following the first n prime integers. The second is the proof of Fermat's famous theorem: that $x^n+y^n=z^n$ cannot be satisfied by integers x, y, and z, not zero, when n is an integer greater than two. This theorem has never been proved unless we accept Fermat's statement that he has done so. When $n=2$ the equation is satisfied by the Pythagorean numbers of which the set giving us $3^2+4^2=5^2$ is very commonly known. Just as many other problems have led to a host of important results until finally solutions were found for them, so attempts to solve these problems have contributed a large amount of mathematical knowledge to the world and the end of their contribution is not yet in sight. Few problems in mathematics can be so simply stated as these, but it is no difficult task to propose many problems which may resist attempts to solve them for many years. Theoretical mathematics, under which head we might classify problems like those mentioned, must continue to pave the way for that which is of immediate use. Conic sections were studied by the Greeks many centuries before Kepler announced his remarkable discoveries on planetary motion.

Institutions of learning should be in a position to introduce their capable students to a number of fields of advanced scientific thought, and must provide the essential mathematical foundations that make such an introduction possible; otherwise they fail deplorably in the obligations they assume in accepting such students. There is scarcely a shadow of doubt that mathematics must play a formidable role in the scientific thought of the future for leaders in the sciences are not only using its material in their work but are urging their students to do likewise. Mathematicians, who will agree with the scientists in their opinion of the power and usefulness of mathematical methods, are more cautious in its use than they, and often are led to wonder if those, who so frequently use mathematical phrases and formulae, really know what they are talking about. Elementary applied mathematics courses which

frequently are too unmathematical to be of great value, are given in the departments of colleges that have need for them because it is felt that the theoretical treatment as given in the regular courses of the mathematics department are unnecessarily thorough. This procedure is very apt to lead directly to the inappropriate use of mathematics; a tendency against which Dr. Edwin B. Wilson[13] warned the members of the American Statistical Association in his presidential address only last December. The same warning has been expressed frequently by mathematicians. At the Glasgow meeting of the B. A. A. S. in 1901, Professor Forsyth said: "*—that there is danger of obtaining untrustworthy results in physical sciences, if only the results of mathematics are used; for the person so using the weapon can remain unacquainted with the conditions under which it can rightly be applied.*"[14]

In order to appreciate the correct use of mathematics, the investigator must not only understand the derivation of that which he uses but must have employed it on problems from other than his own limited field. These conditions are rarely fulfilled by departmental courses where the point of view is limited to a special class of problems. Calculus for the engineer and calculus for the chemistry student cannot be essentially more different than addition and subtraction for the farmer are different from those employed by the business man. Differentiation and integration, which are the only operations studied in elementary calculus, like addition and subtraction, are independent of the fields in which they are used. The same holds for elementary statistics; that used in biology is applicable in educational research. The inappropriate use of mathematics, due to superficial training such as is frequently received in departmental courses, is very easily remarked by one who has a sufficient mathematical background, and will certainly expose those so using it to ridicule and embarrassments. Now the mathematics departments of all schools should try to supply the needs of other departments by offering sound courses in calculus, in the mathematics of investments and

[13]Wilson, Edwin B., Mathematics and Statistics, *Scientific Monthly* (April, 1930), pp. 294-300.

[14]Perry, John., *Discussion on the Teaching of Mathematics*, McMillan and Co., London (reprinted, 1902).

in statistics. On the other hand, other departments must begin to realize that the mathematics which is essential in their work requires more preparation and must be more liberal in its scope than they are willing to concede. Otherwise their students and research men will more and more fall into the ridiculous situations against which Dr. Wilson has warned the statisticians. The danger which may arise through the use of more advanced mathematics will not be nearly so great if the elementary courses here discussed are thoroughly understood by students.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,
The University of Oklahoma, Norman, Okla.

There exists no category of the sciences to which the name of applied science could be given. *We have science, and the applications of science,* which are united together as the tree and its fruit.—*John Tyndall, "Lectures on Light."*

We cannot but think there is something like a fallacy in Mr. Buckle's theory that the advance of mankind is necessarily in the direction of science, and not in that of morals. —*Lowell.*

It is this disposition to find the real nature of the facts in the smallest homogeneous particles, in other words, "atomism," which science in the twentieth century modifies. The parts themselves, considered without regard to their position in the whole event, are nohing. The reality is the organism, the situation as a whole. The unity of a tree is very different from that of a machine, and even physicists are beginning to suspect that they also deal with the former kind of unity. The effect of this change of view upon education is difficult to predict.—*Everett Dean Martin in "The Meaning of a Liberal Education."*

The most important thing in the world is a belief in the reality of moral and spiritual values. It was because we lost that belief that the world war came, and if we do not now find a way to regain and to strengthen that belief, then science is of no avail.—*R. A. Millikan in "The Significance of Radium."*

Distrust of speculation often serves as a cover for loose thinking.—*A. S. Eddington, before the British Association for the Advancement of Science, 1920.*

There is probably no subject in all science which better illustrates the importance to the entire world of research in pure science, than does X-rays. Within three months after Roentgen's fortuitous discovery, X-rays were being put to material use in a hospital in Vienna in connection with surgical operations. Had Roentgen deliberately set about to discover some means of assisting surgeons in reducing fractures, it is almost certain that he would never have been working with the evacuated tubes, induction coils, and the like, which led to his famous discovery.—*F. K. Richtmyer, American physicist, in "Introduction to Modern Physics."*

PREDICTED LOCATION OF THE 1930 CENTER OF POPULATION OF THE UNITED STATES.

By L. S. SHIVELY,

Associate Prof. of Mathematics, Ball State Teachers College, Muncie, Ind.

In connection with each decennial census of the United States, the Bureau of the Census has determined the location of the country's center of population. This center is "the point upon which the United States would balance if it were a rigid plane without weight and the population distributed thereon, each individual being assumed to have equal weight and to exert an influence on the central point proportional to his distance from the point."[1] It is thus seen to be a center of gravity and should not be confused with the "median point," in the determination of which, distance is not taken into account. Alaska and our island possessions are not considered in its determination.

The first center of population, computed for 1790, was found to be in latitude 39° 16′ 30″ north and in longitude 76° 11′ 12″ west, a point about 23 miles east of Baltimore, Md. It has migrated steadily westward, following very closely the thirty-ninth parallel of latitude. At no time has it been more distant from this parallel than 19 miles to the north, while the extreme north and south variation has been only 21.4 miles. The largest westward movement in any decade was that of 1850-1860 which amounted to 80.6 miles. The total westward motion during the interval from 1790 to 1920 was 567 miles, an average of 43.6 miles for each ten years.

The center of population entered the State of Indiana soon after the year 1880 and has been within that state since that time. It is a reasonably safe prediction, based upon recent trends, that it will remain within Indiana at least until 1950. In the year 1910 it was in the city of Bloomington, Indiana; ten years later it had migrated almost ten miles westward to a point 1.9 miles west of Whitehall in Owen County.

---

*Read at the Indiana Section of the Mathematical Association of America, Earlham College, Richmond, Indiana, May 3, 1930.

[1]Statistical Atlas of the United States, 1924, Government Printing Office, page 7.

An attempt has been made to predict the location of the center of population for 1930, basing this prediction upon estimates of population increase over the preceding decade and upon estimates of the change in distribution of the population over the same period. In this connection it is to be noted that the plan used by the Bureau of the Census for determining its location could not be followed.

In brief, the method of the Bureau of the Census consists in determining moments, both east-west and north-south, with reference to a conveniently chosen meridian and a similarly chosen parallel. The country's population is grouped by square degrees. Within each square degree the population of the principal cities is handled separately; the remaining population within the area is regarded as being centered at the geographical center of the area unless, for obvious reasons, a different choice should be made. The algebraic sum of all east-west moments, divided by the total population gives the distance from the selected meridian to the center of population, while a similar calculation gives its distance from the selected parallel of latitude.

The Department of Commerce furnishes yearly estimates of the populations of the states, the most recent one available for use in this calculation being that for July 1, 1928.[2] A careful study of the trend over a period of eight years was used as a basis of an estimate to the nearest thousand of the population of each state (and the District of Columbia), as well as an estimate of its probable error, as of Jan. 1, 1930. These population figures together with the estimated locations of the centers of population of the states, constitute the data for the calculation. Moments were taken by states instead of by square degrees, data for the latter not being available.

In order to estimate the location of the center of population within each state, the trends of these centers during the interval from 1880 to 1920 were used.[3] In most

[2]World Almanac and Book of Facts for 1929, p. 283; Also, Chicago Daily News Almanac for 1930, p. 144.

[3]These centers were first computed in 1880. See Statistical Atlas, page 11.

cases these trends are very well defined. In all cases they indicate with sufficient accuracy for the present purposes, the location for 1930, of the center point for each state.

As illustrations, the examples of several states may be cited. The center of population of California migrated farther than that of any other state during the forty years ending with 1920. By decades over this period its movements have been as follows:

Decade	Southward (miles)	Eastward (miles)
1880-1890	34.9	23.1
1890-1900	12.8	8.4
1900-1910	36.7	20.1
1910-1920	25.4	19.0

The assigned estimate of its position for 1930 assumes a movement for 1920-1930 approximately equal to that of the immediately preceding decade.

The case of Illinois is typical of one in which the trend is very well defined. In 1880 the center of population was a few miles southeast of Bloomington. During successive decades it travelled almost exactly along a straight line toward Chicago by amounts of 14.3, 8.7, 5.4 and 6.1 miles. An estimate of 6 miles in the same direction for the next ten years seems entirely justified.

A similar situation exists in Michigan. Here the influence of rapidly growing Detroit is well marked, the center of population having moved directly toward that city since 1900. There can be no doubt about this having continued through the next ten years.

In the states of Maryland, Massachusetts, Rhode Island and in the District of Columbia the movement has averaged less than one mile per decade since 1880; in 19 other states, less than 5 miles; in 7 others, between 5 and 10 miles; in 13 others between 10 and 15 miles; in 2 others between 15 and 20 miles; and in the remaining four states, over 20 miles.

For the computation of the probable error of the result it was necessary to estimate the probable errors of the population and of the location of the center of population of each state. These estimates were made as

conservatively as possible in conformity with statistics available over past years.

All of the data used in the calculations were tabulated. Populations were estimated to the nearest thousand and locations of centers of population to the nearest minute both in latitude and longitude. Moments were calculated with reference to the 87th meridian and the 39th parallel of latitude. Distances were in all cases reduced to miles.

The final results showed a westward movement of the center of population of the United States during the decade from Jan. 1, 1920 to Jan. 1, 1930 of 13.2 miles with a probable error of 1.25 miles; and a northward movement of 2.8 miles with a probable error of .84 mile. This gives the approximate location as N. Lat. 39° 13′ and W. Long. 86° 58′, a point a little to the southwest of Arney in Owen County.

The one event of outstanding influence upon the center of population of the country was the discovery of gold in California in 1848. During the decade ending in 1860 the population of that state increased over 310 per cent. It was during this period that the center of population underwent its greatest westward movement. The very rapid growth of California since that time is shown by the fact that its rank in population changed from 29th in 1850 to 8th in 1920, and indications are that there will be a close race between California and Michigan for 6th place according to the 1930 census. The continued influence of California is very apparent. Its rapid growth, together with its great distance to the west, has exerted a steady westward pull upon the center of population.

AMERICAN POMPEII FOUND IN ARIZONA.

Evidence of an Indian Pompeii, buried under a fall of black volcanic ash by the last eruption of Sunset Crater, more than twelve hundred years ago, has been discovered near here by an expedition from the Museum of Northern Arizona.

Searching within five miles of Sunset Crater, the expedition uncovered prehistoric sites representing three stages of Indian life in the Southwest. These are late Basket Maker Indians, and the first and second stages of Pueblo culture, which succeeded the Basket Making age. Over the sites inhabited by the two older groups is the sinister black blanket. Not one of the thirteen pit houses of the second Pueblo period shows any trace of the menacing ash.—*Science Service.*

POLARIZED RONTGEN RADIATION.

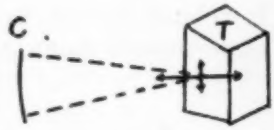
BY M. WISTAR WOOD,

Culver Military Academy, Culver, Ind.

I. PRIMARY RAY POLARIZATION.

X Rays have been proved to be light of very short wave length. Several thousand X waves would make up one wave of ordinary light. They were discovered by Rontgen about thirty years ago, and before announcing his discovery he had acquired a very remarkable knowledge of their properties. It has been said that the research men of the world had to work for six months after his first paper was published, before they were able to discover one single new fact, that Rontgen did not know about these new rays. This paper concerns itself with the polarization of X Rays, and the first researches in this field were conducted by Charles G. Barkla, who published in 1905 the results of his first experiments, measuring the polarization of such a beam.

An electron vibrating in a vertical line sends out a horizontal wave of radiation, but no vertical radiation. The converse action also takes place. That is, a horizontal light wave, or X Ray wave, passing over an electron will make it vibrate in a vertical line. From these considerations, Barkla argued that when the cathode stream strikes the target inside an X Ray tube, it probably sets the electrons of the target, whose vibrations are the source of X rays, into more violent vibration along the line of flight of the cathode stream, than at right angles to it. This is represented by the diagram. The Cathode stream from C strikes the target T the surface of which is at such an angle that the X Rays come straight toward the reader. If we let the two arrows represent the intensity of vibration of the wave, the beam of X Rays is seen to be polarized.



To investigate this. Barkla set up his apparatus essentially as shown in Figure 1. The beam of X Rays was sent thru two narrow slits in lead screens L_1 and L_2 and allowed to fall on a radiator made of some light solid such as paper, or paraffin wax. Two electroscopes of the

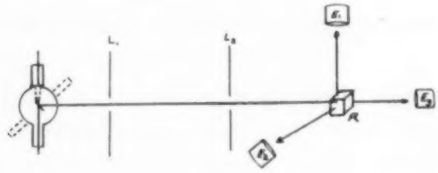
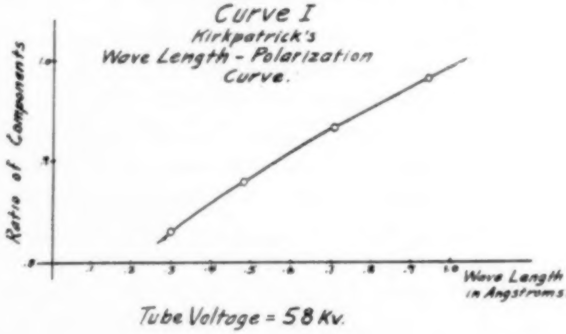


Fig 1
Barkla's Apparatus for Studying
The Polarization of Primary X Rays

old gold leaf type were placed at E_1 and E_2 so that the angle $E_1RE_2 = 90°$. The electroscopes were so arranged that they could be charged together by connecting them to a series of cells, the other terminal of the series being grounded. The rate of collapse of the leaves was then carefully observed when no X Rays were being generated, and again when they were. These two rates gave a measure of the intensities of the X Rays that entered the gas of the electroscope. A third electroscope E_3 was used to measure the change, if any, in the primary beam of rays striking R. As the bulb was turned thru 90°, E_1 or E_2 showed a greater discharge rate, depending on which was in the plane perpendicular to the plane determined by the primary beam, and the Cathode Rays.

Barkla next substituted ionization chambers for the electroscopes, and was able to get more accurate results with this improved apparatus. He found in some cases as much as 10% or 20% difference in the currents observed to pass thru the ionization chambers.

Let us next consider how the amount of polarization is related to the wave length of the X Rays used. By experiments using aluminum filters Kirkpatrick secured

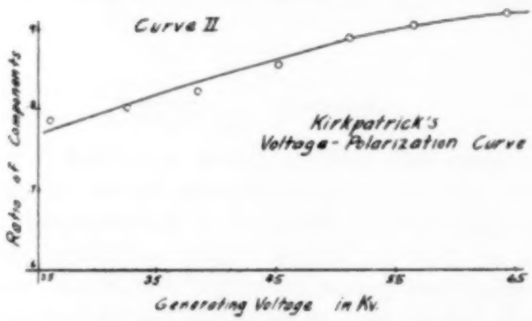


Curve I
Kirkpatrick's
Wave Length - Polarization
Curve.

Tube Voltage = 58 Kv.

data shown on curve I. The filters were of varying thicknesses, from .028 to .280 cm. From his readings, using seven filters, he got seven equations, from which to determine four unknowns. This experiment used about 60 KV on the tube, and would be quite different for other voltages. As the limit of the X Ray spectrum is around .2 Angstroms, it is evident that the primary beam is never more than 20% polarized. This can be explained by assuming that the individual electrons in the target, while each may vibrate in a straight line, and so send out a polarized ray, do not all vibrate in parallel lines. In general, the shorter waves are the more polarized. These results were obtained by Kirkpatrick with a Coolidge Tube, and while his apparatus was essentially the same as Barkla's, he first ran some tests which proved the polarization theory to be the same for both types of tubes.

Another interesting relation is that which is found to hold between the voltage applied to the tube, and the polarization of the primary beam. This could be measured with the same apparatus. The lower voltages showed the greater polarization. Questions of ioniation will limit the voltages that can be used on any tube, but higher voltages give greater velocities to the cathode particles. These greater velocities cause a more heterogeneous vibration of the electrons of the target, and less polarization of the X Rays. Kirkpatrick's results are shown in Curve II,



which is based on the mean primary polarization, no wave length filter being used. Bassler and Vegard carried this work further by placing absorbing substances in the primary beam. This was found to increase polarization, by cutting off the longer wave lengths. The shorter wave

lengths seem to come from nearer the surface of the target, and so are more polarized, as the cathode particles are rapidly scattered as they penetrate the target, and so the long wave lengths, coming from beneath the surface, show less polarization. Filters of copper, aluminum, and lead show a uniform increase of absorption with wave length, but silver and iodine do not, the latter showing absorption discontinuities, and actually cutting off the shorter, more polarized waves. Of course the shorter waves are the more penetrating. By extrapolating curve II it can be seen that with infinite voltage the beam would be unpolarized, and with vanishing penetration, we might have about 50% polarization.

II. POLARIZATION OF SECONDARY X RAYS.

In this field also, Barkla was the first to investigate. He argued that if an unpolarized beam of X Rays strikes an electron, as at e in Figure 2, it will vibrate in a plane perpendicular to the line of propagation of the primary ray, so sending out a secondary wave which lies in a vertical plane perpendicular to the primary ray. This secondary ray will have no components along the line of the primary ray, and so is completely plane polarized.

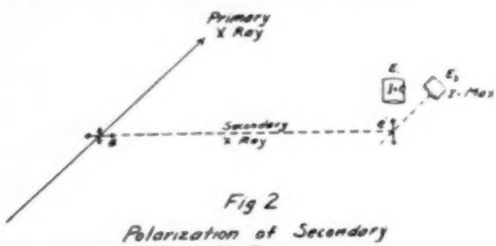


Fig 2
Polarization of Secondary X Rays

Barkla used two carbon blocks at e and é, and found that there was almost no ionization in the chamber at E_1 which was carefully shielded from the secondary rays generated at e. The ionization was a maximum in E_2 when this chamber was placed so that the line $e'E_2$ was parallel to the primary beam. Carbon was used because it gives a secondary ray of considerable intensity, yet differing only slightly from the primary. The results of the experiment showed that the secondary rays from carbon are almost completely polarized. Barkla believed, however, that due to intercorpuscular forces within the atom, the polarization

could not be quite complete. Due to the finite size of the beams, and cross vibrations, etc. the ionization in the minumum electroscope never entirely vanished. This idea of intercorpuscular forces seems to be confirmed when the carbon blocks are replaced by iron. Iron gives secondary radiation different from the primary. It was intense, but absorbable, or soft. While the iron did radiate, there seemed to be no polarization, as the individual electrons in an iron atom are apparently not free to accelerate with the ether waves.

When the secondary radiation given off by air, paper, or some light solids was studied, it was found that the intensity of the secondary rays depended on the position of the plane of polarization of the primary. This can be easily seen from figure 2. If the vertical vibrations at e are reduced, the intensity of the secondary ray is also reduced, regardless of the constant horizontal vibration at e. Barkla found that the secondary radiation from heavy metals was independent of the plane of polarization of the primary, probably for reasons similar to those which account for the failure of the above experiment with iron.

At first Barkla believed that the hardness or softness of the primary rays did not affect the intensity of the secondary radiation, but when he published that statement, he expressed some uncertainty about it, and a year later, after further experiment, he changed his mind.

The mass of the radiator affected the intensity of the secondary radiation, but not its state of polarization, for the ratios of the rates of discharge of the electroscopes remained constant, and the secondary radiation had the same polarization, regardless of what light solid was struck by the primary beam. But this was not true for the heavy metals like iron, lead, or copper.

In 1921 Compton and Hagenow carried these early experiments of Barkla considerably further. The latter had found about 80% polarization in these secondary rays, but the former used refined apparatus, and studied the scattering of the second radiator, placed 12.5 cm. from the first, with an X Ray spectrometer. The work before this time had simply been done on "Secondary Rays," but these men found that part of the secondary radiation is just scattered primary radiation. Another part of the secondary is char-

acteristic of the radiator and its wave length depends on the material. A third part is a fluorescent, high frequency radiation, whose wave length, while independent of the substance used as a radiator, does depend on the frequency of the exciting radiation. This last may be made up of X Rays generated by secondary cathode rays, which were liberated in the radiator by the primary rays. But this explanation is not entirely satisfactory, as the fluorescent radiation sometimes contains 50% of the original energy.

Compton and Hagenow put their attention on this fluorescent radiation, and while it can vary from 15% up, for their set-up they found it to be 70% of the total secondary radiation. This radiation is almost entirely polarized, while the primary X Rays are only about 20% polarized. They are now working on an explanation of these results, based on the "Hypothesis that it is emitted at the instant of liberation of the secondary cathode rays from the atom."

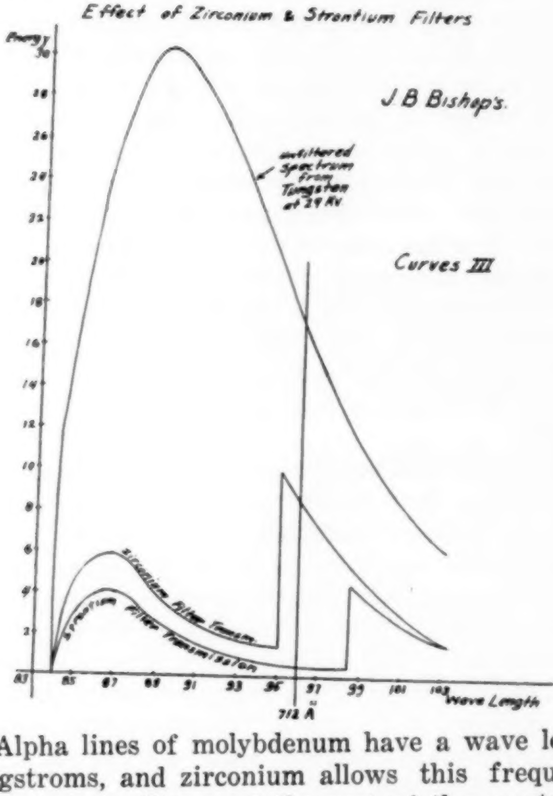
One by-product of this investigation was the fact that by using very thin sheets as radiators, the polarization is considerably increased. By extrapolating to zero thickness they find the ratio of the two components at right angles to be very small. For paper and sulphur this ratio is .05 and for aluminum it is .04.

III. Polarization of Characteristic X Rays.

The second of the three types of secondary radiation discussed above seems to have its nature determined by the material of the radiator. This is the basis of the X Ray spectra worked out by Moseley before the war, and is often spoken of as superimposed on the white radiation. The most important research on these rays was made by Bishop in 1926. If the voltage on the tube is raised above a certain point, the characteristic radiation of the target begins to appear above the white radiation. This was not known or allowed for in most of the investigations undertaken before 1923. So most of these experiments do not contain a record of the voltages used. Kirkpatrick started in this direction when he tried out paper, aluminum, carbon, and iron, but as these were outside the tube, and his voltages were too low, the characteristic radiations were not a factor there.

Bishop knew that the optical spectrum of the resonance

radiation of sodium and of mercury vapor is partly polarized, if it is generated by electronic impact, so he sought for similar phenomena for X Ray spectra. He used a molybdenum target in a big Coolidge tube, and passed the X Rays through filters, as he found he could get better intensity by this method than with crystal gratings. The tube was so set that it could be rotated about its vertical axis, which passed accurately through its focus. The tube was operated at 50,000 volts which did not vary more than ½ per cent. The filters used were strontium or zirconium. The effects of these filters can be seen from a study of the curves III.



The Alpha lines of molybdenum have a wave length of 712 Angstroms, and zirconium allows this frequency to pass, but largely filters out the rest of the spectrum. If a molybdenum target had been used instead of tungsten, for the graph data, Hull has calculated the ordinate for the 712A line would have gone to 98. In other words, with a molybdenum target and a zirconium filter, we get prac-

tically monochromatic radiation, which is characteristic of molybdenum.

By using the strontium filter the rate of discharge of the two electroscopes could be measured, and the results taken as zero readings. When the strontium was replaced by zirconium, the effect of the characteristic radiation could be definitely measured. While other refinements are described in Bishop's original paper, his conclusions are as follows:

"In the light of the evidence of this experiment, one concludes that the Alpha lines of molybdenum are at least partially polarized. The polarization is in the same sense as has previously been found to exist in the general radiation, namely there is a greater concentration of the electric vector parallel to the cathode stream, than perpendicular to it. Whether or not this polarization is peculiar to the alpha lines of molybdenum alone, or is common to all the characteristic lines of all the elements, is a matter yet to be determined. The importance of further investigation along this line can scarcely be over estimated, for certain it is that our knowledge of the true nature of the characteristic emission process is far from complete, and needs to be augmented by more facts. It seems highly probable that unambiguous data concerning the condition of polarization of the complete line spectrum would be helpful to this end."

Kaye, in his excellent book on X Rays, published in 1926, the same year that the above quotation was published, is discussing the best materials to be used as radiators in experiments on secondary X Rays. On page 116 he says:

"The characteristic radiations from materials of very low or very high atomic weight are either very soft or absent altogether. And so Carbon, Paraffin Wax, Aluminum, Lead, and the metals of the Platinum group are ordinarily to be preferred to metals of the Zirconium group, which possess pronounced characteristic radiations. These are not polarized, at least not to any appreciable extent, and their presence only serves to mask the results."

In a few more years our knowledge of the polarization of characteristic rays will no doubt be far greater than it is at present, but after all, polarization only represents one small plot in the great field of X Rays. Rontgen opened

up a new world, that was never even dreamed of, forty years ago.

BIBLIOGRAPHY.

1. C. G. BARKLA: Polarization of Primary X Rays. Phil. Trans. Roy. Soc. A 204, 1905, page 467.
2. C. G. BARKLA: Polarization of Secondary X Rays. Proc. Roy. Soc. A 77, 1906, page 247.
3. J. B. BISHOP: Polarization of Characteristic X Rays. Physical Review, Vol. 28, 1926.
4. BUBB: Direction of Ejection of Photo-Electrons by X Rays. Physical Review, Vol. 23, 1924.
5. COMPTON: Polarization of Secondary X Rays. Physical Review, Vol. 18, 1921.
6. COMPTON: X Rays and Electrons. D. Van Nostrand, 1926.
7. HAVIGHURST: The Scattering of X Rays. Physical Review, Vol. 31, 1928.
8. JAMES: The Polarization Factor in X Rays. Nature, Vol. CXXI, 1928, page 422.
9. JAMES AND FIRTH: Determination of Polarization Factor F. Proc. Roy. Soc. A117, 1927, page 62.
10. KAYE: X Rays. Longmans Greene and Co., 1926.
11. KIRKPATRICK: Experiments on the Polarization of X Rays. Physical Review, Vol. 18, 1921.
12. KIRKPATRICK: Polarization of X Rays as Function of Wave Length. Physical Review, Vol. 22, 1923.
13. J. J. THOMPSON: Conduction of Electricity Through Gasses. Cambridge University Press, 1906.

SUGAR INJECTION SAVES LIFE IN VERONAL POISONING.

The injection of a large volume of sugar solution into a vein enables the patient or the experimental animal to recover from the effects of veronal poisoning, Drs. A. B. Luckhardt and Carl A. Johnson of the Hull Physiological Laboratory of the University of Chicago have discovered.

Veronal is widely used as a sleeping powder for human patients, as well as in laboratory animals, but its use is not without danger and frequently gives rise to serious poisoning. It was known for some time that veronal is execreted slowly and almost unchanged in the urine. If the excretion of the drug could be hastened, the chances of the recovery of the patient would improve.

Drs. Luckhardt and Johnson succeeded in hastening the excretion of veronal through the kidneys by injection of 5 to 10 per cent. grape-sugar solutions into the vein. The injection of about 35 grains of veronal produced by a sleep lasting for 40 hours in normal dogs, but if the dogs received from 1 to 2 liters of sugar solution after the dose of veronal, the recovery time was reduced to between 14 and 18 hours.

A woman who had taken 60 grains of veronal apparently with suicidal intentions, was given one and one-half liter sugar solution three to four hours later. The injection produced marked increase in the secretion of urine; in six hours she passed 1100 cc. of urine. Five hours after the sugar injection she could easily be roused and another six hours later showed almost no symptoms from the drug.

There is little doubt that increasing the efficiency of the kidneys by injections of large volumes of fluids will continue to save life in accidental and intentional veronal poisonings.—*Science Service.*

INSTRUCTIONAL MATERIAL FOR THE SMALL LABORATORY.

By John J. Condon,

Nottingham High School, Syracuse, New York.

In the small laboratory, especially where the instruction in two or more sciences must be given by the same instructor, and perhaps in the same laboratory, the problem of finding good specimen materials and storing them from year to year for other classes involves very careful planning. Much more important is the source of the materials, with economy of space.

Jensen and Glenn[1], have shown that in South Dakota in 1926 "a typical four year high school offered two sciences with an enrollment of from ten to twenty pupils . . . that the value of the equipment was greatest in chemistry and physics. . . . Combined with their teaching 60% has extra curricula duties." Phelan,[2] found a like condition in Ohio and Worstell[3] finds the smaller schools in Iowa introducing chemistry in addition to other sciences. "Getting more students interested in the course is our biggest task," is the teachers' opinion in that section, also.

Such conditions are found, in a similar degree, with each state survey. With the seemingly large number involved it is hoped that this suggestion may be of assistance to many.

The idea of the "Exhibit" is not new. Many colleges as at Rhode Island, Syracuse, Iowa, use extensive exhibits and some high schools have used the idea with success. Reports of some[4] have appeared frequently. The methods we have used and the scope of the undertaking is somewhat different than in the previous articles which were very helpful in our problem.

The desire was to teach the applications of chemistry, creating enthusiasm and interest in chemistry, while collecting materials for future use.

---

[1]*Journal of Chemical Education*, 6, 634-664 (April, 1929).

[2]*Ibid.*, 6, 2196-2202 (December, 1929).

[3]*Ibid.*, 6, 1503-1511 (September, 1929).

[4]A. H. Jacobs, *Journal of Chemical Education*, 2, 792-794 (September, 1925); F. L. Bell, *Ibid.*, 5, 157-167 (February, 1928); J. E. Mahannah, *Ibid.*, 5, 1112-1126 (September, 1928); S. D. Law, *Ibid.*, 6, 1139-1142 (June, 1929); C. H. Stone, *Ibid.*, 6, 1535-1541 (September, 1929); P. M. Bail, School Science and Mathematics, Vol. XXX, No. 2, 195-197 (February, 1930).

After consulting the syllabus and texts used, (1) several items were decided of such importance and degree of difficulty as to lend themselves more easily to forms of illustrative matter; (2) another list was made of the subjects where definite forms of specimen materials would aid in explanation; (3) then those items which would enrich the course were listed. Representative concerns were enumerated for each group, and two or three were placed opposite each item.

As an example, from the first group, the extraction of sulfur by the Frasch method has been difficult for many. How one pipe will fit into the other? Why will it rise? Why can sulfur rise in but one? How can it come out of that pipe? are but some of the questions. Since our exhibit this has been presented in the Journal of Chemical Education, Popular Science and more recently in the Chemistry Leaflet.

The idea of the Exhibit was given to our students in these statements. "An Exhibit will be held in this room in about six weeks. You are asked to help in assembling material which will be solicited. The names of the concerns will be furnished to you as will be the paper for the letters you will write. You will be advised of the materials desired should you not be entirely familiar with the products. Yes, we are going to ask you to supply the stamps. Each will write about three letters, though some will write more than that number. The form of the letter will be suggested, and your writing materials are all that will be necessary in class tomorrow."

From the prepared lists suggestive of different possibilities each student was asked to select a commodity for which he thought he might be able to get an exhibit showing its sources, steps in manufacture, and uses. Form letters were put on the board and three to five names of concerns known to manufacture the item were given the student. Each of the members of the chemistry class was given selected materials or illustrative matter desired from that organization. The same procedure was carried out with the students in physics, although they did not write as many letters. Where possible, one letter was directed to a concern in New York state having the de-

sired information, and others were directed to diverse sections of the country.

The entire period was used in preparing the letters. It was requested that the replies be sent to the individual student in care of the Chemistry Department, and to add prestige, the requests were written on Departmental Stationery.

Every student was urged to secure from every available source all the information possible regarding his product, so that he could best explain its manufacture, properties and uses to the class when it arrived. Prizes were offered for the exhibit or poster showing the most thought on the part of the student arranging it so that it would tell its story most clearly to the visitor.

Interest was indeed keen when the replies began to come in. We found a very marked spirit of courtesy and real interest in almost every reply, even though we did not receive material from every one.

The first part of the period for three days in the two weeks during which the material arrived was used to unpack, examine, and label until the time for the final assembling.

Posters were made by both Chemistry and Physics groups and in some cases titles were suggested but the enthusiasm brought many new titles and ideas most of which were used.

As an example of the posters presented, one on the various combinations of nine of the elements to form many alloys, was condensed very neatly. Another on the chemicals used in the manufacture of the airplane, which gave formulas and sources of materials, was timely and elaborate.

Original posters deserving comment were a "New Periodic Chart,"[5] a set of eight "Cooling Curves,"[6] and one comparing the present and past symbols used in Chemistry.

A list of some of the better posters follows: Chemistry in the Automobile-Metal parts; Other parts. Physics with the Automobile Engine; Electrical System; Other

[5]*Journal Chemical Education*, 6, 553-556 (March, 1929).
[6]*Ibid.*, 6, 776-777 (April, 1929).

parts. Chemistry in the Kitchen. Physics in the Kitchen. Chemistry in Our Outside Pleasures. Physics Helps Us to Enjoy Ourselves. Physics and the Xmas Toys. Evolution of Chemistry. Preserving Foods by Chemistry, Fire Prevention thru Chemistry. Chemistry in Health. Chemistry in Our Home Conveniences. Evolution of Heating Devices. Early Airplane Models. Types of Radio Tubes. General Types of Graphs. Chemistry Dresses the Man. Graphs in Heat, Light, and Sound. Chemistry Helps to Furnish the Home (2). Kill Pests. Chemistry Builds the Home. Chemistry prepares Our Foods. Physics Improves Transportation. Physics Lightens our Work. Chemistry in Milady's Toilet. Modern Airplane Types. A total of 59 posters was made by both groups.

The best arranged exhibit was that done with the products of the Vitresol Company. The most complete commercial exhibit was loaned to us by the Onondaga Pottery Company, a local concern. We were fortunate in being able to have this most instructive and enlightning display which was received from Harvard University the week previous, where it had been on exhibition. It is now a traveling exhibit of that concern to Ceramic schools and colleges. The Stackpole Carbon Company sent a very fine set of their products on a display board. The samples from the makers of Pyrex Glass wear, and the Solvay products were very complete. Obordorfer Metal alloys and metals, given to us by this friendly Syracuse maker of non-ferrous metal products, were used in several posters and to supplement many exhibits. From the northern part of the state which abounds in several metal deposits, was sent a set of samples of Talc from W. H. Loomis Company.

Individual projects using these types of material sent by over one hundred concerns are the following: Common Alloys. Comparison of Liquids (Densities). Evolution of Silk. Making of Bordeaux Mixture. The Story of Steel. How Carborundum is Made. Making of Aluminum. Sensitive Flame. Jumping Helix Coil. Lead Tree. Construction of a Dry Cell (Two forms). Construction of the Storage Battery (Two forms). Building an Electric Motor (Progressive assembly).

These were supplemented by a collection of minerals from some of the western states loaned by Mr. Scott. Mr. Sundstrom of the Solvay Co., loaned a cluster of Sodium Chloride crystals, obtained in a crater of a receded lake in Nevada. Some of the crystals in the cluster measured one and three-fourths inches on a side and were colored due to animal growths. Prof. Kelleter, of the College of Forestry at Syracuse, gave us a copy of the first magazine made from corn stalks. Samples of Rayon, imitation horsehair, and equivalent weights of Balsa and Lignum-vatae woods were some of the other materials he was kind enough to loan to us. None created as much interest as the crystals of Cellobiose and the samples showing the stages in preparation of the compound, which he has made part of our permanent display.

We have been able to include but a few of our many kind contributors, but would send additional information to any desiring the same. You may find your community—parents, friends, industrial plants—will be pleased to help you, too. Our experience suggests that to be the case.

The time set for the exhibit was the week during which a play would be presented in the auditorium. Students of the school were asked to come in the afternoon of the first day. Members of the class acted as ushers and guides. The room was opened before and after the entertainment, and as an added attraction a member of the Physics class, a first class commercial radio operator sent Radiograms to all parts of the United States. This was the initiation of 8 WCJO, the Nottingham High School transmitting station.

It was my impression, as I watched the people pass through and heard their remarks, that the majority of people whom we consider the intelligent class of a community were very much impressed and surprised at the important part chemistry is playing in our everyday lives and many were amazed at some of the facts brought out by these exhibits which we as chemistry teachers consider as very matter-of-fact information. Yet the general public does not realize the tremendous importance of chemistry and here, I believe is a wonderful means of "selling" it to them.

EIGHTH GRADE GENERAL SCIENCE FOR MILWAUKEE JUNIOR HIGH SCHOOLS.

BY GENERAL SCIENCE COMMITTEE, W. F. ROECKER, CHAIRMAN.

SAFETY FIRST*

I. MOTIVATION AND INTRODUCTION.

1. Accident reports in newspapers may be made the introduction to the subject.
2. A class tabulation of accidents in the home during the past year may arouse special interest in this topic.
3. Show the class a Universal Safety Calendar and discuss its merits.

II. MAJOR OBJECTIVES.

1. To cultivate a deep appreciation of the social and economic value of human life.
2. To give a clear understanding of our civic responsibility to our fellows and the community as a whole on matters of safety.
3. To instill proper habits looking toward conservation of life, better health, preservation of property and respect for law.
4. To learn from careful inquiry that most accidents are avoidable.

III. INFORMATION FOR THE TEACHER.

1. Cost of Accidents.

Each year in the United States there are about 80,000 deaths and 2,000,000 non-fatal accidents.

In 1922 in the United States there were 19,000 children killed in accidents, and 450,000 seriously injured. This represents a financial loss of over four and a half million dollars in education alone. (From Payne and Schroeder's book.)

In the Annual Report of the Milwaukee Safety Commission on Traffic Accidents and their Causes, 1928, on page 2, we find: "The analysis for the year 1928 includes 11,472 accidents of all kinds (traffic), as compared to 12,135 in 1927 and 11,834 in 1926. This is a decrease of 3.6% over 1926 and 5.5% over 1927. Although the reduction is fairly small it must not be overlooked that

*The preliminary report of this unit was prepared by a sub-committee composed of F. Schriever, W. J. Hall, and F. L. O'Reilly.

this is the first year that a reduction in the total number has been shown."

In the year 1924 there occurred 22,766 accidents in Wisconsin which were settled by the Industrial Commission. The damages paid were $3,047,147 and the doctor bills $1,153,332.

2. The cause of accidents.

Carelessness is one of the main causes of accidents. It ranks at the top, or near the top, of any statistics available. It is the thoughtless man that has "hard luck." It is he that puts a box on a chair to reach a picture on the wall, topples over, and has "hard luck." More accidents in the home are due to falls than any other cause. Many automobile accidents result from poor brakes and improper headlights.

Why take chances? Why take a chance by crossing a street against traffic or by crossing it in the middle of the block? "A *chance* taker is an accident maker." To be cautious does not mean to be afraid. All the ordinary things in life can be done without taking chances.

Hurry is another fruitful cause of accidents. Hurry may not mean speed. Why hurry to gain a minute and lose a life?

Some accidents are caused by *ignorance*. This is particularly true of electrical accidents. People may not know how to use the material or tools that they are working with.

It is well to remember that "accidents do not happen; they are caused." If we stop to think and eliminate carelessness, chance taking, and hurry, then we shall reduce the number of accidents.

3. Accidents in the Home.

It is well to utilize the experience the children bring to school as basic material and to direct these along proper lines. The home is likely to be the center of such experiences at this age, and as a great percentage of accidents occur here, the teacher will have available much that can be used.

(1) Order in the Home. "A Place for Everything." Clothes, chairs, toys, books, and utensils if left about anywhere, are likely to lead to falls and cuts. The teacher

may here use short stories of accidents or newspaper clippings illustrative of injuries caused by things being out of place. "A Fall May Cripple for Life." The most common injuries in the home probably are caused by falls.

Make a list of situations which lead to serious falls in the house and recommend proper precautions.

(2) Health and Emergency Rules: "Lookout for the Armies Against Life." Immediate care of cuts, bruises, scratches, and skin eruptions is important in the life of young people. This work introduces bacteria which should be studied only in a very elemental way. The eating of food that has been dropped or handled, without cleansing may also be discussed.

Present the following emergency topics and show clearly what treatment is best in each case: (a) Accidents to teeth. (b) Frost-bite, especially to nose and ear. (c) Burns. (d) Cuts and how to stop bleeding.

(3) Fire Hazard: "Do not Fan the Flames." If clothing should catch fire, one should not run as the increased supply of oxygen makes it burn the harder. Smothering the flames by rolling on the ground or by wrapping in a blanket or carpet is the proper thing to do.

Here again orderliness in the care of the electrical utensils, care of heating devices, and disposal of waste material may be emphasized.

Discuss the following topics with the class: (a) How to leave a burning building. (b) How to rescue persons from a fire. (c) Care of ashes. (d) Spontaneous combustion. (e) How to handle gasoline. (f) Fire hazard in handling moving picture films.

(4) Electrical dangers. "Charged wires mean Danger." Some of the elements of electrical safety can be developed on a good reasoning foundation. The pupils, especially boys, have a fair knowledge of elemental electricity that may be drawn upon. The meaning of such terms as conductor and insulator can be easily developed.

All electrical work is supposedly done according to the National Electric code, a publication distributed by the National Fire Protection Association, Boston, Mass.

But it is unfortunate that much of our electrical work is not done according to this code. Such a condition is tragic when we consider the reports of insurance companies on losses due to imperfect wiring.

Discuss: (a) Danger of live wires and how to rescue persons from them. (b) How to resuscitate from electric shock. (c) Cautions to be observed with Christmas trees.

(5) Gas. "Carbon-monoxide Gas is Deadly." Posters and newspaper clippings on death in garages due to running motors may be used here. Also a study of the gas stove and means of keeping children from turning on gas jets.

(6) General.

Following is a list of home accidents that may be used as illustrative material:

Doing repair work, step ladder slipped, strained back. In bedroom, put hand on dresser and needle stuck in finger—infection and finger amputated. Opening jar of olives, top of jar broke, cut index finger. Brushing coat, hand caught in scissors in pocket. Cutting piece of wood, knife slipped, cut deep in thumb. On porch, stepped off backward, bruised foot, infection. Splitting wood with hatchet, slipped and cut part of thumb. Chopping wood, axe flew out of hand, deep gash in foot.

4. Accidents in school.

Accidents in school, are relatively few in number. Every means should be used to avoid them as any accident, no matter how caused, reflects upon the school. Some that occur will be the same as under the preceding topic: falls, cuts, bruises, burns, fire hazard, and electric dangers.

The cause of accidents is again carelessness or disobedience in not following instructions.

A student should be instructed to report every accident to his instructor.

Make a list of situations in school where carelessness or disobedience may lead to accidents. Discuss the most important items noting especially how such accidents may be avoided; also, what emergency equipment should be on hand and how school accidents should be treated.

5. Accidents outside the school: On the street; in

travel; and during vacaton. State why the following cautions are important. Select five which you consider most important for most people.

(1) Cross streets only at the crossing.

(2) Place sand on the walks in front and around the house.

(3) When going to and from hunting trips keep knives guarded and guns unloaded.

(4) When traveling in unfamiliar places be cautious and learn the safety rules, for instance on boats and in neighboring cities.

(5) Shut motor of car off when filling with gasoline.

(6) Be cautious with matches.

(7) Be equipped with spare tire and tools in case of an accident.

(8) Do not go in deep water if you cannot swim.

(9) Obey the rules at railroad crossings.

(10) Do not stand near steel poles or wire fences during electric storms.

(11) Do not play with sharp tools.

(12) Be sure garage doors are open when motor is running (carbon monoxide gas).

(13) Drive slowly while passing a school.

(14) Do not play in or near the street.

(15) It is unwise to catch rides on trucks.

For the vacation period the safety precautions for travel on railroads, street cars and automobiles should be stressed. This applies especially to street crossings. In summer the dangers arising from carelessness in boating and swimmng should be emphasied; in winter, accidents come from skating on thin ice, from sledding, and slippery streets.

A short discussion may be had on the treatment of cuts, burns, sunburn, sunstroke, poison ivy, dog bites, the poisonous effect of impure water and contaminated food—and not to forget, a "Safe and Sane Fourth." Never point a gun at a person, even in fun. Many "unloaded" guns have exploded.

IV. PROBLEMS: CHALLENGING QUESTIONS

1. What is the purpose and work of the Milwaukee Safety Commission?

2. What traffic rules affect the pedestrian?

3. Why does the Electric Company use salt on car tracks in the winter?

4. Why does sand prevent skidding on Milwaukee streets in winter?

5. How may an electrically shocked or a drowning person be revived?

6. How can one determine arterial or venous bleeding?

7. Why should all "Pyroxilin Plastic" material be kept away from heat?

8. What are the three most common causes of fires?

9. Explain what is meant by spontaneous combustion.

10. Why are arms often broken when cranking cars?

V. DEMONSTRATION AND EXPERIMENTS.

1. What is the proper way to resuscitate a person from drowning? Place the person on the floor or ground face down. Open the mouth and give access to plenty of air. Place a stick in the mouth in case it will not stay open. Then straddle the man to be worked on and place your hands in the hollow of his back, just at the lower part of his ribs, press in and forward firmly and slowly forcing the water out of the lungs and stomach. Then release the hands quickly the air will tend to rush into the lungs. The more quickly the hands are released the greater the tendency for the air to force its way into the lungs.

Another method of inducing artificial respiration: After expelling the water from the stomach and lungs lay the patient on his back. Then take a position on your knees behind the head of person. Grasp the arms just below the elbows with the patient's forearm parallel with yours. Draw the arms slowly backward away up over the head. This will expand the chest both upwards and outward. Next push the arms forward until the upper part of the arm presses against the ribs. Enough pressure should be applied here to drive a good deal of the air out of the lungs. This double operation is kept up until the patient recovers or all hope is gone. This method is called the Silvester method of artificial respiration.

2. Place sand on a slippery walk then try to slide

on it as before. What happens?

3. With a miniature traffic model, show how automobile accidents occur.

4. Illustrate the application of bandages in a safety first campaign, or as an assembly program.

5. Demonstrate the proper use of machines in the various shops.

VI. VALUES.

This unit should result in the pupils making an active effort to help reduce the number of accidents. They should become more careful and use every opportunity themselves to set a good example. Their conceptions of their own civic responsibility should become enlarged. Pupils should become impressed with the fact that most accidents are avoidable.

VII. PROJECTS AND PUPIL ACTIVITIES.

1. Organize the class into a safety club and let them plan a safety program.

2. Have a poster contest on safety. (Within the Board's rules.)

3. Organize a safety campaign.

4. Make a scrap book of newspaper pictures and clippings on accidents.

5. Determine how traffic rules prevent accidents.

6. Build and equip a first aid cabinet.

7. Dramatize proper entering and leaving of street cars.

8. Make a trip through an industrial plant and observe all the safety precautions making report to the class.

9. Memorize the antidotes for several common poisons.

10. Dramatize the traffic rules, first aid, and fire prevention for either class or assembly programs.

VIII. SUPPLEMENTARY MATERIAL.

1. References.

(1) School Safety Bulletin issued by Milwaukee Safety Commission in the City Hall. Safety Facts for School Teachers.

(2) Health and Safety in the New Curriculum. Payne and Schroeder American Viewpoint Society. New York. A Teacher's Training Book.

(3) Safety First for School and Home. Beard. 1925.

The Macmillan Company. Contains the outline of a Safety First course for the first eight grades.

(4) Boy Scout Hand Book. Good for first aid.

(5) Education in Accident Prevention. Payne. Lyons and Carnahan.

(6) Safetyize. National Safety Council. Chicago, Illinois. Issued free by the Milwaukee Safety Commission. Good material for home accidents.

(7) Annual Report of the Milwaukee Safety Commission on Traffic Accidents and their Causes. Very good local reference.

(8) An Introduction to Safety Education. National Safety Council. Chicago, Illinois. It is a manual for the teacher and may be obtained from the Milwaukee Safety Commission, City Hall. Contains project.

(9) First Aid Handbook. Bauer and Black, Chicago, Illinois.

IX. VISUAL AIDS. Motion Pictures. The following may be obtained from the Bureau of Visual Instruction Madison, Wisconsin, for the transportation after paying the yearly fee of $12.00.

Title	Reels	Cost
Danger that Never Sleeps. Fire Prevention	1	Free
Forests Green or Forests Gray. Fire Prevention in national forests	1	Free
The Menace. The danger of fire—Automatic sprinkler systems	2	Free
Play Safe. Treats of Safety in the street	1	Free
Safety Devices. Safety in factories and shops	1	Free
Safety First. Factory guarding against accidents	1	Free

The following may be obtained from the Milwaukee Public Museum at a cost of $1.00 per reel.

Safety in the Mine. Shows miners receiving instruction	1	$1.00

INFANT DEATHS DECREASE IN U. S.

The death rate of babies during the first year of life has decreased considerably in this country during the last fifteen years. At present the rate is 67 per 1,000 births. This does not yet equal the very low rate of New Zealand which has for years held the record in the matter of a low infant death rate. There the present rate is 36 per 1,000.—*Science Service.*

ARTICULATION OF NATURAL SCIENCE SUBJECTS IN HIGH SCHOOL.

By L. Paul Miller,

Head of Science Department, Central High School, Scranton, Pa.

The science teacher may to great advantage adopt methods which utilize as many close connections as possible between his subject matter and the materials handled by teachers in other departments.

We may go farther, and say that he must, of necessity, adopt methods which take into account all connections between his particular science subject, and any previous science subjects. If these connections were shown as lines in a diagram they could be horizontal ones, with the life situations, and the subjects in other departments, and vertical ones with previous science subjects.

No vertical connecting lines would be drawn, with subsequent sciences, in high school or in college. Many of the pupils never have a chance to make such connections. Besides, if our diagram were to show all the high school and college science subjects, it would be evident, according to our arrangement, that subsequent subjects would be taking care of these connections. Simply phrased, each subject should start where previous ones stop, and should have a fairly definite stopping-point of its own, where any subsequent ones that a pupil might study, can begin.

The figures seem almost unbelievable, and might admit of various interpretations, but one analysis of subject matter in science text-books* indicates that pupils studying average general science texts who reach the subsequent science classes, are already equipped with: 34.5% of the biology, 25% of the chemistry, and 41.4% of the physics that they will encounter in texts in these subjects.

Whether or not we accept these figures as a basis, the fact remains that there is much duplication in texts. Some day a group of capable secondary school science teachers, conscious of the proper aims and methods of science teaching, will prepare a set of four volumes to be used as science texts in the successive high school years. Perhaps partitions between the separate sciences will be forgotten. At

*Leker, W. R. Articulation of General Science with the Special Sciences. School Science and Mathematics, 25:724-37, October, 1925.

least, duplication of identical topics will be avoided, except by way of review where needed to lead on to new topics. The publishers who first put out such a set are likely to do a good business.

Properly unified texts are not yet available. The teacher must make the needed adjustments. The method used in the writer's own experience, and probably the one in general use in schools where careful organization of science work is attempted, will be briefly described.

There is first of all a definite science department organization. This is essential for many purposes other than attempting proper articulation. In schools in which a department is not officially recognized, one can be informally organized, by the selection of an acting chairman, and the holding of well planned conferences.

Definite schedules are prepared for each science subject. Daily schedules cannot be closely adhered to, but weekly ones can be followed fairly well. A course at least begins at a certain fixed point, and embraces certain definite topics, and then closes at a fixed point.

Analysis is made of the subject matter of all texts and reference books used. Certain topics are selected for special stress, others for less, and some are dropped entirely. Much of this is experimental, and frequent modifications are made.

Range of information tests are given at the beginning of each semester, in each subject. Topics in which results are very good, receive little further attention. Where the weakest showings are made, additional treatment is given.

At the beginning of each semester, also, in each subject, the questions in the final examination of the preceding semester are discussed in class. These frequently have no bearing directly, or what is to follow in the new subject. They are given attention for these reasons:

(1) Pupils should be led in every possible way to consider previous and present science subjects as constituting a continuance course of study in natural science, regardless of the unnatural partitions which are placed in the way.

(2) Review of topics previously covered is frequently worth while. There is no law against discussing photosynthesis in chemistry or physics classes, for example, even

though it seems to be the property of the biology texts.

(3) Many relationships between the natural sciences can be pointed out during discussions of another science in any science class.

(4) As a general rule, any questions given pupils at any time should so far as possible be followed by statements of the correct answers. The examination questions at the end of the biology course, for example, are no exception. The answers are given the next year in physics class, if physics follows.

(5) Pupils who may be free to make electives and may not study biology, for instance, but take physics the following year, get at least a sketchy idea of topics they missed.

(6) The teacher who teaches one subject only, keeps in touch with at least one other science subject in preparing to discuss questions on that subject, in class.

Through proper organization of a science department, numerous attempts can be made at desirable uniformities of method in the separate subjects. Types of tests and final examinations, for instance, can be decided upon. If multiple-choice tests are uniformly used in four years of science work, there is much economy of time evident. These should certainly not be used exclusively, but when they are occasionally used, the pupils are always on familiar ground.

It is wise also to carry over many practices in science laboratories from one year to the next. Methods of procedure, in general, should vary very slightly. It is a matter of minor detail, but there seems to be a great advantage in using note-book sheets of uniform size throughout the science work. A single binder suffices. At the conclusion, a single, uniform record exists, of all of the laboratory results. (Loose-leaf notes should be kept in filing cabinets until the close of a semester's work, then returned to pupils for purposes of review in class, and finally taken home to be bound with previous notes.)

It should be required uniformly in all subjects that all mistakes made on laboratory record sheets be corrected promptly. It is deemed best to permit no laboratory notebook work to leave the laboratory until the completion of it. It should be a matter of uniform practice to have the

greater part of the required laboratory work in the special sciences done by the pupils individually, rather than in pairs or groups.

These are examples of practices that may to great advantage be followed throughout the successive years. If any other practices are in use, whatever they are should be followed in all years. Lack of uniformity in procedure throughout, results only in confusion of the pupils.

Any separate list of specific methods in separate subjects, have purposely been omitted. Such distinctions would directly contradict what has just been said about the desirability of uniformity throughout all years. There are no special methods of direct value in one subject only, and others of use in some other year exclusively. If we are to accept fairly common aims, we need to use methods that are fairly common, in all stages.

Some of these methods will of course be more frequently used in one stage than another, depending on the desired ends. We have shown that the aims may be given varying stress in different years. The appropriate methods to be used would be stressed accordingly. For example, the project method may be most frequently used in the early stages, because it may be found useful in introducing to beginners many of the topics that lend themselves to such treatment. In later stages, the project method may appear less often in actual practice, yet many of its essential principles may still be recognized as valuable, and almost unconsciously applied. The project method is not therefore assigned to certain subjects, to the exclusion of others.

Of various methods of conducting classes, such as: lecture, lecture-demonstration, recitation, socialized recitation, developmental, and the like, none belongs to any one science subject, but all have their proper places in all subjects. There should be uniformity here, in that all classes should make use of all methods, as occasion demands. Some methods are best suited to some topics, and other methods to other topics.

Proper articulation is greatly hindered if a pupil is compelled to change from exclusive use of the project method in general science, for example, to unrelenting use of the lecture method in biology. A particular teacher may con-

sider his practices to be consistent if he daily uses the socialized recitation method, from one year to the next. But his pupils pass on to another teacher the next year, and probably to another method. There may be uniformity of practitce with reference to a given teacher, but not with reference to the pupils, unless all teachers agree on the socialized recitation. It seems much simpler to agree on all useful methods, and then to vary the class proceedings somewhat by using all of them, sooner or later, for appropriate purposes. This may not be precisely the view of either the fundamentalist in science teaching, or of the modernist. Therefore it ought to be a comparatively safe and feasible one.

DESTRUCTIVE COTTON PEST FOUND IN PACKAGE MAILED FROM INDIA.

Several pink bollworms stowed away in a small package of cottonseed sent by mail from India met a timely death recently when the package was examined by a plant quarantine inspector at Atlanta, Ga. The pink bollworm is a destructive pest of cotton, regarded by entomologists as at least in the same class with the boll weevil.

In its long journey from India to the United States the package had been crushed, leaving a hole in one side large enough for the pests to crawl out, according to Tom O'Neill, assistant State entomologist and representative of the U. S. Plant Quarantine and Control Administration, who inspected the shipment. He immediately ordered the contraband package burned, thus preventing a potential invasion by this pest.

Although a special quarantine, designed to prevent the entry of the pink bollworm, prohibits the importation of cottonseed into the United States, this package was sent by an agricultural official of India, the original home of the pink bollworm, and was addressed to an agricultural official in the heart of our cotton belt.

This case presents a striking example of the possibility of introducing dangerous plant pests into the United States through the mails, says Lee A. Strong, chief of the Plant Quarantine and Control Administration, the branch of the Department of Agriculture whose duty it is to see that foreign plant pests and diseases are kept out of the country.

"The Plant Quarantine and Control Administration enjoys the full cooperation of the Post Office Department," Mr. Strong said, "but it requires little imagination to appreciate the magnitude of the task of detecting among the millions of packages which reach the United States from foreign countries those which contain plant materials, and which may harbor plant pests."

The numerous channels of modern transportation and communication by rail or ocean, by motor vehicles, airplanes and dirigibles, afford abundant avenues for the invasion of our country by plant pests not already established in the United States. Unfortunately, Mr. Strong says, these pests fail to bring their natural enemies with them.

MATHEMATICS AND ITS PLACE IN THE CURRICULUM IN ELEMENTARY AND SECONDARY SCHOOLS.

BY JOHN J. HALL,
Palo Alto, Calif.

One of the oustanding problems facing students of education today is the one of curriculum content. The statement that "Nothing shall be retained in the curriculum for which a constructive case cannot be made out" has resulted in actually dropping Greek, in bringing Latin into a state of unequal equilibrium and, in certain sections of the country, particularly the west, in a rather concentrated attack on mathematics.

There are several causes apparently contributing to this situation. (1) There have been and still are many pupils failing each year in mathematics particularly where pupils are not selected or classified. It is claimed by some people that this is due to the difficulty of the subject. (2) There is an apparent dislike on the part of many pupils for arithmetic and for mathematics in general. (3) The present demands for a greatly "enriched" curriculum requires that a modern school shall present every sort of subject from carpenter work to orchestra—from plumbing to politics. I propose to point out that these things are due not to the subject itself but to:

(1) The attitude of teachers toward the subject and their manner of teaching it.

(2) A consideration of mathematics as a "tool subject," i. e. as a computational rather than an interpretive subject.

(3) A lack of understanding of the real objectives to be attained in teaching mathematics.

(4) The attempt to give to all pupils the same course of study in mathematics regardless of their ability or aptitude.

(5) A lack of appreciation on the part of those in authority for the fact that number is a "social institution" which the race must have.

(6) The mistaken notion that every subject taught must have an *immediate* practical application.

These reasons are not of equal importance. Some are

over-lapping and some are the results of others. Let us examine them briefly.

The attitude of many teachers toward mathematics has been to regard each lesson as merely one more task in the day's work. There are teachers who are not interested in their work and who are but using their positions to fill the gap between the present and whatever lies ahead. Then too, there are a large number of teachers whose training has been very narrow. They look upon mathematics as a "tool" and emphasize only the facts and processes that the subject contains. Such teachers blindly follow a text book day after day. They lack the initiative to seek out the underlying principles of their subject. Their attitude is that if they tell a child HOW to do a problem that is all that is necessary. They either cannot, or do not care to, exert themselves to tell WHY a thing is done in a certain way. These teachers have not been trained to recognize their opportunities or they lack the necessary background which is required if they are to put real enthusiasm into their teaching.

On the other hand, there are teachers who take the time and trouble to carefully prepare each lesson and who consciously strive to relate it to the actual experiences and life interests of the pupils. These teachers have no trouble in arousing the interest of the class and of getting an enthusiastic response from almost every child. Anyone familiar with the classroom will recognize these two types of teachers.

The notion that arithmetic is a tool subject is still generally accepted by many people. Recently a graduate student of Columbia University wrote his Doctor's thesis on what should be taught in arithmetic. He expressed the belief that it was sufficient merely to teach a child a dozen or so simple rules for computing numbers. As a matter of fact, computation is but a very small part of our use of numbers. We can scarcely express an idea without bringing in some notion of number. Most of our activities in life are in terms of number. Numbers are used to record the day and year of our birth, numbers are used to designate our every act, our houses and telephones are listed as numbers, our daily schedules and appointments are made by means of numbers. Our debts,

taxes, incomes and automobile licenses are expressed numerically. And when our lives are over and we are placed in a numbered plot of ground more numbers are inscribed upon our tombstones. The use of numbers to furnish information is as important as their use in computation. Number is not an abstract something that is used but once or twice a day by the man upon the street. Instead it forms the very backbone of our life, and, without it, the race would revoke back to the days of savagery. Number is the one universal language and the degree to which it is used by any people is a sure index of the degree of their civilization. The teachers of mathematics should recognize this universality of number and guide their pupils to an appreciation of the value of precision, accuracy and clarity of thought that is made available by the use of numbers and of mathematics in general.

The danger that lies ahead of the person who has no understanding of figures beyond his ability to manipulate them is illustrated by a story told by Dr. Charles Judd. When the United States entered the World War, a commissary officer in Washington sent in an order for supplies and provisions for the armies. He knew the amount of food that was required for the army in peace time and the number of men in the new forces. Hence he made up his list of supplies by means of direct proportion. Among the items ordered were a certain number of cases of canned raspberries. The amount was checked and passed upon by the senior officer. A few days later word was received that if the entire world could be devoted to the cultivation of raspberries there would still be an insufficient amount to fill the order!

The failure to interpret the meaning of numbers is often the cause of misunderstanding if not of down-right disaster. We are accustomed to using large numbers in our every day speech without really understanding what they mean. Our newspapers often refer to billion dollar corporations and astronomers discuss distances in terms of light years. When a person realizes that Christ was crucified only about one billion minutes ago, he can never again regard such a number without a feeling of awe and

respect. Such stories as these are of interest to the children and they enliven the discussion period in a striking manner.

However, there are other objectives to be kept in mind in teaching mathematics. From the very beginning of the study of numbers stress should be laid on the value of precision for it is closely related to every phase and process of the subject. A false step at any point in reasoning weakens or destroys the whole line of thought. Accuracy and clear and exact thinking is essential throughout. It is true that certain other subjects lend themselves to the development of these desirable habits but not to the same degree. It is possible in moth mathematical problems to check results step by step. Moreover, there is usually but a single correct answer to a problem. Two educated people may differ in their points of view on almost every other subject under the sun, but in the solution of a mathematical problem they will, as a rule, agree on one answer. In connection with this thought, David Eugene Smith asserts that the laws of mathematics are fixed and unchanging. History, language, customs, medical practice, theories of chemistry and physics, religions and people are constantly being changed, but $(a+b)^2$ has been, is, and always will be $a^2+2ab+b^2$. He goes on to say that "Mathematics increases the faith of a man who has faith; (it) shows him his finite nature with respect to the infinite; (it) puts him in touch with immortality in the form of mathematical laws that are eternal, and (it) shows him the futility of setting up his childish arrogance of disbelief in that which he cannot see."[1]

Dr. George B. Olds expressed the same thought when he said that "Mathematics is the only science which can develop a knowledge of absolute truth."[2]

Moreover, in the mathematics classes, children can be shown the value of orderly and neat arrangement of their work. In geometry, especially, opportunity is given for developing continuous lines of reasoning which lead to exact conclusions. When a child realizes that a definite

[1]D. E. Smith, Religio Mathematici, Math. Teacher Dec. 1921.
[2]G. B. Olds, Mathematics and Modern Life, Math. Teacher, Apr. 1928.

answer can be obtained to a problem, he may be led to develop resourcefulness and persistence to a marked degree. The certainty of mathematical laws, the precision and accuracy of thought that is demanded, the advantage of order and arrangement of work, and the opportunity for the child to check his own work and thus eliminate errors should be constantly and consciously kept in mind by the teachers of mathematics each day. The writer knows of no other subject that is so well adapted to give the child this kind of training.

The fourth reason for the attack that is being made upon mathematics is concerned with the old policy of requiring all pupils to take the same courses in the subject. Such a policy cannot possibly be justified. It is true that society demands that every individual possess certain fundamental facts of arithmetic and to be able to handle ordinary sums with a fair degree of facility. Just how much of this knowledge is needed is open to debate at the present time. Investigations are being made and data are being collected which will doubtless be the basis for some constructive work along these lines. As the writer has attempted to point out, however, such knowledge and skill form but a very small part of the values to be derived from a study of mathematics. For those pupils who are not mentally equipped to appreciate the significance of the meaning of algebraic theory or Euclidean logic, and for those pupils whose interests lie distinctly in other lines, it is a mistake to require them to take the same courses as those pupils who are preparing for engineering or for teaching mathematics. The latter type of pupils will need a rather rigorous training in the techniques of algebra, geometry, and trigonometry, but even these pupils should not be taught in such a way as to develop a narrow and limited point of view. It is the general practice in most schools to teach algebra, plane geometry, solid geometry and trigonometry as separate and distinct units. Recently certain progressive teachers have been pointing out the advantages of eliminating such distinctions and advocate a richer course in mathematics which is composed of these various subdivisions. A short time ago an "A" pupil in high school

mathematics began his work in one of the eastern universities. At the end of his freshman year he chanced to meet one of his former high school teachers. In the conversation which followed, this pupil stated that the university did not teach any mathematics, instead it taught elementary functions and calculus. Such an incident as this could not have happened if both the high school and the university had had in mind a broader point of view and had brought out the intimate relationship between the various parts of mathematics.

This will not help the situation, however, to any great extent in the case of those pupils whose interests and abilities are in other directions than mathematics. These pupils should be given courses in mathematics which are designed to develop an appreciation for the subject and an understanding of how closely it affects their whole lives. For example, they should be led to see how all art, music, science, medicine, industry, etc., depend upon mathematical laws. They may be shown why mathematics has been called the "patriarch of all sciences." They may be brought to see the truth of Plato's statement that "God eternally geometrizes." When mathematics is translated into terms of every day experiences these pupils will no longer regard the subject as a drudgery and something to be despised. We will not be producing a class of pupils who are forced to build up what the psychiatrists call "defence reaction" towards mathematics. At the present time such courses as suggested above have not been carefully worked out to any great extent. A few teachers are working along these lines and there are wonderful opportunities for real contributions in this field.

The sixth reason for the distrust that some people have for mathematics is that they cannot see how it is going to benefit those who study the subject. There is, and probably always have been, a group of practical-minded folks whose pass word has been "Yes, But what is the use?" Nearly a century ago when Faraday first demonstrated that an electric current was induced in a moving conductor when it cuts through a magnetic field, one of his friends asked him "what is the use of it." Far-

aday's answer was "what is the use of a new born baby?" We know now that he had discovered the electric dynamo. Many people believe that Guglielmo Marconi discovered wireless telegraphy—the forerunner of radio. What he actually did was to apply the principles that Maxwell had predicted and that Heinrich Hertz had discovered. When the first automobiles appeared they were considered as mere playthings but today their manufacture ranks first in industry. When the Wright brothers made their first airplane flight and stayed aloft about two minutes, nobody had sufficient faith or vision to realize what this flight would mean to the world. These are but a few of the incidents that might be mentioned in which the question had been asked "what is the use?" Throughout the history of the race mathematics has guided our progress and usually paved the way for further advancement. Professor Schlauch has pointed out that mathematicians today are a half century ahead of the philosophers in their interpretations of the problems of philosophy[3] and Dr. Osler is quoted as saying that "medicine will become a science when Physicians learn to count".[4]

In conclusion, I would say that it is the sacred duty of every educator to carefully examine the whole mathematical field before he undertakes to assert that all the mathematical training a child needs can be taught him in the first three or four grades in school.

[3]Schlauch, W. S., Mathematics as an Interpreter of Life, The National Council of Teachers of Mathematics, Third Yearbook, '28.
[4]Judd, C. H. The Fallacy of Treating School Subjects as Tool Subjects, National Council of Mathematics. Third Yearbook, 1928.

THE MOUNTAINS PAY TRIBUTE TO LOUISIANA.

"Ship by water and save on freight bills" is a slogan for shippers, boat owners, and politicians. River transportation has always been important in empire building and in opening trade routes. But the rivers do not only transport men, maize and machinery. The Mississippi River annually carries in solution one and one-third billion cubic feet of material, carries along in suspension eight and one-fourth billion cubic feet, and drags along on its bottom three-fourths of a billion cubic feet of sand and gravel. This sand and gravel together with the material held in suspension would supply enough material to build a wall from New York to San Francisco thirty feet high and twenty feet thick; but instead of constructing a Great Wall to hold back barbarous hordes this mighty engineer is building plantations in the land of sugar cane and cotton.

SCIENCE AS A MEANS OF INTERNATIONAL UNITY.*

By Harvey A. Zinszer,
Kansas State Teachers College of Hays.

It is with considerable reluctance and with no little embarrassment that I read publicly for the second time an effort so futile in its achievement and so difficult in its development. Hence, to those of you who have heard its first reading, I offer my most humble apology.

A rather singular and somewhat gratifying coincidence exists in connection with this article in that two months before Dr. Millikan's famous Des Moines speech on "The Alleged Sins of Science," in which his major premise is based upon an accusation against Science by Dr. Harry Fosdick, the present speaker had referred to a similar criticism which together with abstracts from an address on Naval Research on the one hand, and, a lengthy list of international scientific accomplishments and arrangements on the other, formed the gist of the paper.

I commence then, as before by referring to a statement of a prominent lecturer and writer who but a few months since had permitted himself to be quoted by the public press to the effect that the more scientific this world became, the more selfish would the hearts of men become.

In an address on Naval Research before Section M of the American Association for the Advancement of Science, C. S. McDowell, of the U. S. Navy, makes this assertion: "The causes of war are many; among others may be mentioned the pressure of increasing populations and national desires for obtaining greater resources as represented by natural and artificial wealth." He continues, "Any steps the pacifists can take which will tend to harness the above forces will be welcomed by everyone; but as long as these forces remain uncontrolled, the possibility of war must be recognized."

Mr. McDowell, who is an avowed preparedist, probably not in point of numbers but surely in point of efficiency, refers to the various devices which were developed under the competitive stress of the recent war. He concludes that

*Read before the Science Group of the Kansas State Teachers Association at Salina, Nov. 1, 1929; also before the Kansas Association of Chemistry, Physics and General Science Teachers at Wichita, Feb. 1, 1930.

all these developments would have been more effective had they been available for immediate use upon our entry into the war. Consequently, the directive coordination of naval research should be conducted both in peace and in war by the professional naval officer.

It may seem rather difficult to reconcile the spirit of a movement, which involves the enlistment of our best scientific talent into the national military services, with the Kellogg Treaty, the flights of Lindbergh, and the conference of Dawes and MacDonald, not to mention the present London parley. Thus, we wonder whether the competitive spirit inferred by Mr. McDowell, is so keen among the first class nations that the present agitation and negotiations for arms limitation are mere sham. And, we question just why and how much must we arm ourselves; and, is armament the chief factor in the question of World Brotherhood?

For an answer to the former question, we must refer to our diplomatic corps, to our Department of Intelligence and to those military leaders who are in direct touch with our outposts in insular and foreign possessions; and, most probably also to our captains of finance. In his heart, however, the speaker feels that the fundamental answer to the entire question of World Brotherhood, lies in the moral purity and the Christian uprightness of the nations.

Having thus raised and answered these questions somewhat to his own fancy, it is the speaker's privilege, henceforth, to select at random and describe more or less briefly a number of transactions and events of international importance relevant to science as a peacemaker.

If one were to consider the various types of international transactions in their chronological order, perhaps the first to come to our attention is the bequest of James Smithson, an Englishman, who died in 1829 and left his fortune to the United States of America to found at Washington an establishment under the name of the Smithsonian Institution "for the increase and diffusion of knowledge among men."

Dr. Langley, late secretary of the Institute, states that the establishment for the Smithsonian Institute at the time when it came into existence, was a matter of supreme importance for the development of science in America. At

that time the funds for research were small and the avenues of publication inconsiderable. Two or three important scientific societies were in existence, but their funds were limited. Nobody among scientific men anywhere acknowledged a leader and at a time, too, when most important investigations both in the physical and natural sciences were being made. President Roosevelt, in his first message to Congress, remarks that the advancement of the highest interests of national science and learning, and the custody of objects of art and of the valuable results of scientific expeditions conducted by the United States have been committed to the Smithsonian Institution.

In contrast with the Smithsonian bequest, let us consider for a moment the work of the Rockefeller Foundation, an American institution, whose philanthropic work has found objects not only in England, but in China and in other parts of the world. A recent number of Science summarizes the work of this Foundation as follows: "For the strengthening of influential medical schools in many parts of the world from London to Singapore, the Foundation has expended about $29,000,000.00. This does not include building, equipment and support of the Peking Union Medical College and aid to the hospitals and the premedical sciences in China."

International harmony and good-will are also reflected in the various international conventions for the purpose of considering scientific problems of international concern, an example of which, is the famous London Radiotelegraphic Convention of July 5th, 1912. This convention was precipitated by the lamentable disaster of the steamship Titanic. The scope of the contract which was signed by every maritime nation on the globe, included the following requirements on the part of the subscribing parties: Compulsory intercommunication without distinction of system employed; an international code by means of which each letter of the alphabet should be represented by the same signals in all languages; a set of international abbreviations including an international distress signal; a rigid requirement for due regard in the reception and relaying of distress signals; an international bureau for the allocation and publication of rates, call letters, wave lengths, and nature of service of all stations; licensing of both stations

and those operating the same; compulsory connection on the part of coastal stations with land lines; and, the transmission by strategic stations of meteorological radiograms, time signals and other important maritime information.

Before the war, international science congresses met but rarely in the United States but since the resumption of international relations, there have been congresses of botany, agriculture and entomology; and, lately congresses of physiology and psychology, the former at Harvard during August, the latter at Yale during September. These congresses were successful beyond expectation, especially in the attendance from abroad. Concerning the Physiological Congress, it was remarkable that more Europeans were in attendance than ever on their own continent. The general superiority in command of language manifested by the guests from abroad afforded food for reflection. In the case of the Psychology Congress, the foreign members were welcomed by Dr. William John Cooper, commissioner of education, summoned from Alaska by President Hoover to perform this office. Time will not permit a continued discussion on other of these international congresses, however, it is fitting that we mention one more, the World's Engineering Congress meeting in Tokio at this very time. Thirty-two American engineers and scientists under the chairmanship of Dr. Elmer A. Sperry, are attending this convention.

Another agency in science tending to unify the nations are the scientific explorations which take place in various foreign countries and their possessions. A recent example of this is the plant exploration which is taking place at the present time in French Madagascar under the direction of Dr. Charles F. Swingle, botanist, of the Bureau of Plant Industry at Washington. The exploration is being sponsored jointly by the Bureau of Plant Industry and the Arnold Arboretum of Boston. Dr. Swingle is working in conjunction with the University of Algiers and is benefiting by the friendly interest and numerous courtesies of the French and Madagascar governments. Various similar explorations could be cited but the foregoing example will suffice for our purpose.

The establishment of international prize foundations is

not without its good influence upon the tranquility of the nations. One of these is the Nobel prize founded in 1896 by Alfred Bernhard Nobel, Swedish chemist and engineer, inventor of dynamite and other high explosives. Upon his death, Nobel left the bulk of an immense fortune in trust for the establishment of five prizes to be apportioned as follows: one share to the person who shall have made the most important discovery or invention in the domain of physics; one share to the person who shall have made the most important chemical discovery or improvement; one share to the person who shall have made the most important discovery in the domain of physiology or medicine; one share to the person who shall have made the greatest contribution to literature; and one share to the person who shall have most or best promoted the fraternity of nations and the abolition or diminution of standing armies and the formation and increase of peace congresses. In his will, which was drawn up without legal aid, Nobel stated specifically that in the awarding of the prizes, no consideration whatever be paid to the nationality of the candidates.

In connection with the discussion of prizes, mention might also be made of various international medal awards in the field of science. Perhaps the most representative of this type of recognition, are the awards of the Royal Society of London. Five medals, the Copley medal, two Royal, the Davy and the Hughes, are awarded by the society every year; the Rumford and the Darwin medals biennially; the Sylvester triennially and the Buchanan quinquennially. The first of these originated in a bequest of Sir Godfrey Copley, in 1709 and is awarded to the living author of such philosophical research, either published or communicated to the society as may appear to the council to be deserving of that honor; the author may be an Englishman or a foreigner. The Rumford medal originated in a gift from Count Rumford, in 1796 of 1000 pounds 3% consols, for the most important discoveries in heat or light made during the preceding two years. The Royal medals were instituted by George IV, and are awarded annually for the two most important contributions to science published in the British dominions not more than two years nor less than one year before the date of the award. The Davy medal was founded

by the will of Mr. John Davy, F. R. S., the brother of Sir Humphrey Davy, and is given annually for the most important discovery in chemistry, made in Europe or Anglo-America.

The exchange of professors and the awarding of foreign scholarships is still another example of international beneficence and unity. A Cornell list of non-resident followships in chemistry will illustrate the point. This chair was established in 1926 by George Fisher Baker and provides for a new incumbent each year. The following appointments have been made to serve one year each commencing with 1926: Prof. Ernst Cohen, of the University of Utrecht, Holland; Prof. Fritz Paneth, an Austrian, of the University of Berlin; Prof. Alex V. Hill, Foulerton Research professor of the Royal Society of London; Prof. Paul Walden, University of Rostock, Germany; Prof. George Barger, University of Edinburgh, Scotland; Prof. Hans Pringsheim, University of Berlin; Prof. F. M. Jaeger, University of Gröningen, Netherlands.

The awarding of foreign scholarships will be illustrated by brief descriptions of the work of the Rhodes and Rockefeller Scholarship Foundations. John Cecil Rhodes willed the bulk of his vast estate for the purpose of founding scholarships at Oxford, each valued at 300 pounds a year to be held by students from every important British colony, and from every state and territory of the United States of America. The sum thus bequeathed was very large, but it was not for the munificence of the legacy that the will was received with acclamation throughout the civilized world; it was for the striking manifestation of faith which it embodied in the principles that make for the enlightenment and peace and union of mankind, and for the fine constancy of Rhodes' conviction that the British Empire, which he had been proud to serve, was among the greatest of organized forces uniting for universal good.

Two brief sentences tell the story of the Rockefeller gift: Up to December 31, 1928, fellowships had been granted to 3,187 representatives of 58 countries at a total cost of $4,908,743.00. The international significance of these fellowships may be inferred from the fact that 1,383 of the total fellows pursued their studies in countries other than their own.

While there are numerous other striking instances of scientific activity tending toward the furtherance of international unity, it may be wise to conclude this humble effort by referring briefly to two current events of rather historic significance: First, the good-will flights of Charles A. Lindbergh, who after he had made the first non-stop flight from New York to Paris, and upon the invitation of President Calles of Mexico, made a non-stop flight from Washington to Mexico City on December 13-14, 1927, and continued his mission southward to include 16 countries of Central America, Northern South America and the West Indies. And, second, the broadcasting in America of Albert Einstein's voice from remote Germany upon the occasion of the celebration of the Fiftieth Anniversary of the invention of the electric lamp by Thomas A. Edison. This celebration took place at Detroit and the principal guest of honor was Madam Marie Curie, twice recipient of the Nobel prize.

Thus, we realize that Science knows no language save that of Truth; and those who would be her servants yearn to know her speech, finding great joy and pride in the acquaintanceship of their comrades in arms regardless of race or tongue. It is they, the servants, who understand what the great Newton meant, who when dying, uttered these significant words: "I know not what the world will think of my labors; but as for myself, I feel like a little child amusing itself on the seashore, finding here a smooth pebble, and there a brilliant shell, while the great ocean of truth lies unexplored before me."

FLORIDA USES MORE FERTILIZER ON CROPS THAN ANY OTHER STATE.

Cincinnati, Sept. 10.—With an average of 798 pounds of fertilizer used on every acre of crop land during 1929, Florida leads the United States in the use of fertilizer, R. O. E. Davis, research chemist of the U. S. Bureau of Chemistry and Soils, told members of the American Chemical Society. Next to Florida is New Jersey with 417 pounds per acre. On the whole, the states of the Atlantic seaboard use it much more extensively than those inland, though a great increase in its use has come since 1913 in the Pacific Coast states, and there is also a tendency to increased use in the West North Central states. Cotton uses on an average 108 pounds per acre, though 31 per cent. of all the fertilizer used is on this crop. On citrus fruits the rate is 1163 pounds. Five principal crops consume about 82 per cent of the fertilizer, though less than 25 per cent. of the acreage devoted to them is fertilized.—*Science Service.*

NATURE STUDY IN THE LOS ANGELES CITY SCHOOLS.

BY W. L. NOURSE,
John Burroughs Junior High School, Los Angeles, Calif.

Nature Study in the Los Angeles city schools is begun in the kindergarten, and is included in every grade through the eighth.

The objectives of the courses in nature study are indicated in the following quotation from "Course of Study for the Kindergartens, First and Second Grades, Los Angeles City School District."

"Nature Study is the science which places children into proper relationship with the living. It acquaints them with the fundamental principles of life, by widening their sympathies and deepening their appreciation. It creates in the child a responsibility as no other subject does. It makes a demand for service, in the care of pets and all natural things. It stimulates observation because on the one hand the children are continually seeking things of nature which are to be used or enjoyed, and on the other hand they are in constant unavoidable contact with the phenomenon itself."

The contents of the courses in Nature Study are shown by the following quotations from a bulletin issued by the director of Nature Study, Dr. Charles Lincoln Edwards.

"Primary Nature Study should concern itself largely with the rocks, plants, and animals in and around the home. Chickens, lizards, cows, pigs, gophers, dogs, cats and other pets are as interesting species as any imported from foreign lands. Sense education is of such importance that it is associated with Nature Study all through the year. The teacher selects from the subjects offered those locally most available, including as many neighborhood excursions as possible. The child is naturally an investigator and should be given opportunity to make his own stories, recording his own observations illustrated with his own drawings.

"For the third to the eighth grades our Nature Study runs through a cycle of six years. The minimum essentials of Nature Study are given each year. These include stars, rocks, soil, wild flowers, shrubs, trees, seaside life, insects, fishes, amphibia, reptiles, birds and mammals. For instance the dog and its wild relatives represent the mam-

mals for one year. In succeeding years mammals of the circus, native wild species and other mammals are introduced. A child enters the Nature Study cycle at any place in its course and has something new each week. He goes through his whole grammar school without the repetition of a type and yet each year gains an increasing knowledge of the most important divisions of animal and plant life and of stars, rocks and other subjects of inorganic nature.

"Our plan is to devote three or four weeks to each principal subject. The time of the year for presentation of local wild types is determined by relation to the season.

"Descriptions of the Nature Study types written in untechnical language together with teaching suggestions are published when needed in the series of the Nature Study Bulletin for the year. Each teacher is to master this subject matter and make whatever adaptations may be suited to the grade. Insect, bird and mammal stories, in words easily understood by children, and in part illustrated are used as readers to unify Nature Study with Language Study.

"For detailed supervision each of the seven assistant supervisors has charge of a fraction of the 300 elementary schools. The class room is the unit upon which assignment is based. In the development and conduct of the museum of the Nature Study division each assistant supervisor serves as the curator of a section.

"The central Nature Study headquarters contains offices, library, paintings and museum. There are cases for the display of special exhibits of specimens, habitat groups, reference and loan collections. Circulating materials include rocks and minerals, pressed plants, crabs, insects, shells and seaside life, birds and mammal skins in celluloid tubes, mounted skins for museum loans, living guinea pigs, white rats, fishes, amphibians, reptiles, insects and other types when programed for study. Our ideal is to establish such complete collections that a teacher, pupil or citizen may identify any specimen found in Southern California.

"Aquaria, both glass and screened vivaria and various types of cages, contain sea anemones, crabs, spiders, insects, fishes, amphibia, reptiles, birds and mammals. White rats and guinea pigs are widely circulated throughout the school

to be observed and cared for as pets. Exhibits are changed in accord with the semester program.

"Visiting teachers and pupils, singly or in groups, parents with their children and citizens, are made welcome to the nature room. They are interested in everything from the pet Gila monster and the cockateel to the human skeleton.

"When possible a museum is developed in each school. If a nature room is not available cases are placed in one of the halls or some class room, especially if there is departmental teaching. Instructions are issued for the preservation and mounting of specimens, and for making blue prints and ink or carbon prints. We give out plans of live boxes for the display of living specimens in the school with directions for the care of the creatures.

"School excursions are taken in the neighborhood, to parks, the zoo, seaside and mountains, cow and goat dairies, alligator, ostrich, pigeon, rabbit, lion and other farms. Groups of children, chaperoned by teacher or parents, study stars in the neighborhood or at one of the observatories.

"There is an annual general excursion to the seaside at the time of the low minus tides of November. The annual Mt. Wilson excursion comes just after the end of the rainy season in early May. The plant species have been labelled by the staff some days before the excursion. Many birds and occasional mammals, reptiles and amphibians appear. The children, in parties of twenty to a teacher, are interested and happy. Seven miles of these earnest young naturalists scattered along the trail in the California sunshine is a picture never to be forgotten.

"In cooperation with the Los Angeles Playground and Recreation Department week end groups of teachers are assembled in the Griffith Park Camp for training in nature guiding. These nature guides in turn will inspire and instruct their pupils. Some will be selected as nature guides for the High Sierra and other mountain camps. In this manner the hundreds of citizens who frequent these camps will learn of nature where heretofore they have given most of their time to physical recreation."

By frequent bulletins the teachers are directed in their work, and given information on the nature topics which are being studied.

Some teachers, instead of following the regular outline of the courses are taking up, after consultation with their supervisors, one subject—minerals, for example—and following it for an entire term, correlating it with every other subject possible, as English and geography. This procedure tends to increase pupil activity.

SOME SUGGESTIONS FOR BIRD FIELD TRIPS.

The following suggestions are prepared for all who wish to make field trips for bird study, and will be found especially suitable for 4-H Agricultural Clubs, boy and girl scouts, and similar groups and individuals:

1. Spring, early summer, and autumn are the best times of year, but winter is good for some kinds of birds.
2. Early morning and late afternoon are the best times of day.
3. Go alone, or with as few companions as possible.
4. Take a notebook, field glasses, and wear inconspicuous clothes.
5. Pick out places that are good for birds; and cover different kinds of country.
6. Keep quiet and make no sudden or conspicuous movements.
7. Take notes and write them down at the time; do not trust to memory.
8. Identify every bird seen, and study its field marks (bill; head; wings; feet; tail; colors of plumage; shape; actions).
9. Notice:
   - (*a*) Kind of place in which seen.
   - (*b*) How many seen.
   - (*c*) Whether in flocks or singly.
   - (*d*) Method of flight (slow; fast; flapping; sailing).
   - (*e*) Whether the bird walks; hops; climbs trees.
   - (*f*) Disposition (shy; tame; quarrelsome; etc.).
   - (*g*) Actions (quiet; active; peculiar).
   - (*h*) Relations with other birds.
   - (*i*) What use is made of feet; tail; wings; bill.
   - (*j*) Notes (kinds and differences).
   - (*k*) Songs (kinds and differences).
   - (*l*) Food (kind; how and where obtained and how eaten).
   - (*m*) Mating.
   - (*n*) Nest (where situated; materials; how built).
   - (*o*) Eggs (number; size; shape; colors).
   - (*p*) Young (number; how fed; behavior; how soon they leave nest; etc.).

Reference Books:

Henshaw, Fifty Common Birds of Farm and Orchard, U. S. Dept. Agriculture Farmers' Bulletin 513. (For sale only by Superintendent of Documents, Government Printing Office, Washington, D. C., price, 25 cents.)

Kalmbach and *McAtee*, Homes for Birds, Farmers' Bulletin 1456. Free on application to U. S. Dept. Agriculture.

Reed, Bird Guides: (*a*) Land Birds East of the Rockies; (*b*) Water and Game Birds East of the Rockies; (*c*) Land Birds West of the Rockies. (Obtainable from book stores.)

Hoffman, Birds of the Pacific States. (Obtainable from book Stores.)

Eastern Association of Physics Teachers

One Hundred Fifteenth Meeting

LOWELL TEXTILE INSTITUTE

Lowell, Mass.

SATURDAY, MAY 10, 1930

PROGRAM

9.45 Meeting of the Executive Committee.

10.00 Business meeting.
Report of the Treasurer.
Reports of Committees.
Election of New Members.
Other Business.

10.30 Address of Welcome: President Eames of Lowell Textile Institute.

10:45 Address: "The Relation of Physics to the Textile Industry, including the Measurement of the Physical Properties of Textile Fabrics." Prof. Herbert J. Ball, Head of Engineering Department, Lowell Textile Institute.

11.30 Demonstration of Apparatus. E. A. P. T. Apparatus Committee, Mr. John C. Packard, Brookline High School, Chairman.

12.00 Address: "The Measurement of Color and Lustre as Applied to Textile Fabrics." Assistant Professor A. Edwin Wells, Engineering Department, Lowell Textile Institute.

12.45 Luncheon at the Institute Dining Room. Price 80 cents.

1.45 Inspection of the Lowell Textile Institute with members of the faculty as guides.

3.00 Baseball Game. Members will be guests of the L. T. I. Athletic Association.

OFFICERS FOR 1930-1931

President, BURTON L. CUSHING, Mechanic Arts High School, Boston, Mass.

Vice-President, LOUIS A. WENDELSTEIN, High School, Everett, Mass.

Secretary, WILLIAM W. OBEAR, High School, Somerville, Mass.

Treasurer, WILLIAM F. RICE, Jamaica Plain High School, Boston, Mass.

BUSINESS MEETING.

The following were elected to membership:

ACTIVE MEMBERS

Morton H. Cassidy, 32 Grantland Road, Wellesley Hills, Mass.
James F. Conway, High School, Lowell, Mass.
John E. Corcoran, High School, Brookline, Mass.
Dorothy W. Gifford, Lincoln School, 301 Butler Ave., Providence, R. I.
William F. Greely, High School, Gloucester, Mass.
F. Arthur Hilton, Jr., Thayer Academy, South Braintree, Mass.
Anna E. Holman, Winsor School, Pilgrim Road, Boston, Mass.
Chester F. Prothero, Beaver County Day School, Hammond St., Brookline, Mass.
Alton L. Rhoads, High School, Stamford, Conn.
Hugh A. Smith, Ricker Classical Institute, Houlton, Me.
Edward M. Tucker, Perley Free School, Georgetown, Mass.
Leonid Tupper, Derby Academy, Hingham, Mass.
Ralph E. Wellings, High School for Boys, Dorchester, Mass.

ASSOCIATE MEMBER.

George N. Varney, High School, Bangor, Me.

It was voted to postpone till fall the visit to inspect the new organ at the Metropolitan Theater.

It was voted that the thanks of the Association be extended to the Lowell Textile Institute for its hospitality and to the speakers and others who helped in arranging this meeting. After the lunch the members, in groups, were shown over the whole plant after which many attended the ball game.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE.

ROBERT W. PERRY, *Chairman*,
High School, Malden, Mass.

The Bell System Technical Journal:

"Fusion of Wave and Corpuscle Theories," by Karl K. Darrow, January, 1930.

Literary Digest:

"Day of the Big Rain," April 19, 1930. Concerning unusual weather conditions on January 14, when it rained everywhere in the United States.

Motor:

"Packard Diesel Aviation Engine," April, 1930. Description of this new light-weight Diesel which can be operated at very low cost.

Review of Reviews:

"Science, the Soul of Prosperity," May, 1930, by John J. Carty, Vice President of American Telephone and Telegraph Co.

Scientific American:

"Revising Our Air and Our Water," May, 1930. Discoveries due to the study of infra-red spectra.

"Michelson," May, 1930. An appreciation of America's foremost Optical Physicist.

Radio News:

"Evolution of the Vacuum Tube," May, 1930, by Dr. Lee De Forrest. An interesting article by the Inventor.

Science News-Letter:

"Earth's Attraction Being Measured," April 12, 1930. Brief account of project to establish an absolute gravity station at Washington.

SCHOOL SCIENCE AND MATHEMATICS:

"The Cosmic Ray in High School Physics," by H. Emmett Brown, March, 1930.

"Better Demonstrations in Physics," April, 1930, by N. Henry Black.

"Does the Ether Drift?" April, 1930. A summary of the ether-drift experiments, by D. H. Palmer.

Teachers College Record:

"What Are Girls and Boys Getting from Their School Course in Science?" April, 1930, by A. W. Hurd.

School and Society:

"High School Physics Makes Small Contribution to College Physics," April 5, 1930, by A. W. Hurd.

ADDRESS OF WELCOME.

BY PRESIDENT CHARLES H. EAMES,

Lowell Textile Institute, Lowell.

It is a great pleasure to welcome here today the members of the Eastern Association of Physics Teachers and we trust that your meeting will be most profitable as well as enjoyable. There is much in your work and interests that is common to ours and we wish you to know of our work. It is through the basic training in Physics, Chemistry, and Mathematics that the young men coming to us from the preparatory schools can acquire a wider and deeper knowledge of the textile industry. There are many examples of the fundamental laws of Physics in the processes of textile manufacture and we believe that through your acquaintance with these your knowledge of applied as well as theoretical Physics will be widened.

The development of the textile processes of manufacture has been radically different from the growth of many of our modern industries.

Out of what was in early days a household duty, through necessity for quantity of material and a natural specialization of labor, has come the factory with the application of power to machines and processes that had been operated by hand. This has brought machine developments in size and intricacy. Invention in machine parts as well as in methods was greatly stimulated, but I doubt if many of these inventions and designs, as wonderful as they have been, were the results of systematic scientific procedure based on a full knowledge of Physics and Mathematics. The operation of these machines and the control of the various processes were largely a matter of skill and the industry is to a great extent an art not a science. This skill, with accompanying facts and general knowledge, was transmitted from one individual to another through experience. Particular knowledge in producing certain results was kept secret and closely guarded. The lack of the laws of science, which were operative in producing these results, stifled progress and confined manufacturing knowledge to a few.

The establishment of institutions to promote textile education had primarily the object to train the more ambitious in the known facts, processes, and machines made use of in the manufacture of the

common fibres into yarns and fabrics. This Institute originally organized as the Lowell Textile School had other objects. In addition to the dissemination of known facts it has aimed to seek out and emphasize the basic laws of science involved in the several processes and mechanical operations. With this training in fundamentals the student and the future textile manufacturer have not only a better command of prevailing methods and machines, but also a vision of expansion, improvements, developments, and research. This is true not only in the field of manufacture and production, but also in the subsequent channels of marketing and consumption. Textile Manufacturing then is a branch of engineering requiring for its development the same basic training as do the other well known engineering professions.

As these have required the sciences and a foundation so we have and are requiring them. This then is the common ground where the interest of an association like this and our Institute can join forces to work for the improvement of an industry that is a necessity for our existence and to encourage young people to enter it with the assurance that it offers a livelihood which is profitable and honorable.

THE RELATION OF PHYSICS TO THE TEXTILE INDUSTRY, AND TO THE MEASUREMENT OF THE PHYSICAL PROPERTIES OF TEXTILE FABRICS.

BY PROFESSOR HERBERT J. BALL,
of Lowell Textile Institute.

I will present my discussion of the above topic under two headings, first the relation of Physics to the textile industry, and secondly, the measurement of the physical properties of textile fabrics.

Men like yourselves who are familiar with all that is implied in the terms kinematics, dynamics, mechanics of solids, mechanics of liquids, mechanics of gases, heat, light, sound, and electricity can appreciate the breadth and scope of Physics. We know that it is a fundamental, underlying, basic and essential subject for all who are going to enter upon any branch of scientific work. Let me take time here not to tell you of the scope of Physics but the scope of the Textile Industry because until I have given you an idea of its breadth you will perhaps not appreciate to the fullest extent the relation of Physics to that industry.

I shall not burden you with a great many statistics but would like to present these few to point out the relative standing of the textile industry in respect to the sixteen major industries of the country. The latest figures which I have been able to obtain indicate these facts. The wage earners of this industry number approximately 1,700,000 and in this respect it stands first. It pays wages which

amount annually to $1,700,000,000 and here again it ranks in first place. The value of the raw materials which it consumes amounts in the course of a year to $5,400,000,000 a fact which places it in second rank, and the value of its finished product is expressed by $9,100,000,000 again placing it in second position. The comprehension of the magnitude of these numerical quantities may serve to give an idea of the size and scope of that industry concerning which I bring you a message this morning.

It would next be in order to tell you something about the textile fibres which the various branches of this industry use and at the same time to give you an idea of the materials which are made from them. Beginning with wool, an animal fibre, we find this largely entering into the manufacture of men's and women's dress goods, overcoatings, sweaters, robes, upholsteries, various kinds of felts, carpets, rugs, blankets, and underwear. Silk, another animal fibre, finds its most important use in the manufacture of dress goods, underwear, hosiery, linings, and ornamental fabrics such as draperies, tapestries, scarfs, etc. In the industrial field it is used for the insulation of electric wire, for the construction of gas bags for dirigibles, and a certain kind of silk cloth is used as one of the finest sieves. Rayon, the artificial silk fibre of which we hear and read so much at present, is being used for practically all the same purposes which I have enumerated for silk, and it is a matter of common knowledge that the production and use of this fibre has grown enormously in the past five years. Although its physical properties in some respects are not quite the same as those of silk, there is no doubt in my mind but that the chemical processes involved in its production will in time be so changed and improved that the artificial product will finally be equal and possibly even better than the fibre which it is replacing.

Cotton, a vegetable fibre, is one the consumption of which exceeds that of any other fibre which I have named. It enters not only into the construction of very fine dress goods but it is the most important commercial fibre for industrial use. For example we find it used alone or in combination with other fibres for ginghams, shirtings, sateens and many dress goods purposes, for underwear and hosiery, for upholstery and ornamental material, for

blankets, sheetings, towels, spreads, awnings and numerous other household purposes. For industrial purposes we find that it is the basis of our so-called mechanical fabrics, hose and belting ducks, canvases, tire cords and fabrics, artificial leather, airplane wing fabric, balloon cloth and is used in many other places and ways where the strength of a textile fabric is an important consideration.

In addition to the important fibres which I have just mentioned, there are several others which I will enumerate briefly. There are the vegetable fibres known as ramie, hemp, jute, and flax from which are manufactured various kinds and grades of ropes, twines, burlaps, linens, etc. Asbestos, a mineral fibre, surprising as it may seem, is spun into yarn and woven into fabrics in much the same manner as are the other fibres. The safety of automobile travel in a large part depends upon brake band linings made of asbestos cloth.

This enumeration of various uses of textile fabrics does not pretend to be complete by any means but I have given it to you in the hope that I might more forcibly impress upon your mind the extent, magnitude and scope of this industry which we call Textile. The average person, I believe, does not fully realize the extent of the use of textile fibres.

We believe so thoroughly in the importance of Physics in the training of the Textile Engineers who graduate from this Institute that I will take just a moment to show you its place in our curriculum. The chart (now upon the screen) shows the division of the subjects of the Textile Engineering Course into four major groups. The first contains the Textile subjects, the second the Engineering subjects, the third the Business subjects, and the fourth the General subjects. From the names of the courses you can judge that the training of a Textile Engineer consists fundamentally of mechanical engineering, together with a goodly portion of electrical engineering, plus a thorough grounding in all textile processes. This training is rounded out by the subjects in the Business and General group. The names of such subjects in the Engineering group as Mechanics and Statics, Mechanical Laboratory, Heat Engineering, Strength of Materials, Electrical Engineering, and Engineering and Electrical Laboratory indicate their

dependence upon Physics and Mathematics as fundamental sciences. My purpose will be to make more clear to you the relation of Physics to the Textile Manufacturing subjects which are listed in the Textile group, namely Cotton Yarn Manufacturing, Woolen Yarn Manufacturing, Worsted Yarn Manufacturing, Weaving, Dyeing, Finishing, Knitting and Textile Testing. When I have concluded I trust I will have made plain the reason why we believe Physics to be so essential to the training and future work of our Textile Engineers.

In order that you may understand some of the references which I shall make to textile terms I must give you just a brief insight into the manufacturing processes. Let us consider first the size of the fibres which are used, by taking the size of a human hair as a yardstick, and assume its average diameter to be about .00332 inches. Cotton fibres have a diameter varying from approximately $\frac{1}{4}$ to $\frac{1}{5}$ of that of a hair and their lengths range from approximately $\frac{3}{4}$ of an inch to $1\frac{1}{4}$ inches. The diameter of the woolen fibre is about $\frac{1}{3}$ to $\frac{1}{6}$ of that of the human hair and their lengths vary from about 2 inches to 5 inches. The length of a silk fibre is practically continuous and its diameter ranges from $\frac{1}{2}$ to $\frac{1}{8}$ of that of our yardstick, and rayon is now being produced in a form practically as fine as that of silk. Such is the character of the raw materials with which the textile manufacturing processes start.

From the tangled mass of cotton fibres which you see in this sample and proceeding by regular steps by means of machinery which you will see in your trip around the Institute, there is produced roving like that exhibited here. This roving consists of fibres which have been parallelized and which are uniformly distributed throughout its length. It has no tensile strength because it has no twist. The last step in the production of yarn consists in the drawing down of this roving to its proper size and then giving it its final twist (illustrated with picture of spinning frame).

Cloth is produced from yarn by means of the loom. The essential parts by which the interlacing of the threads is accomplished are the harnesses and top rolls, the lay, shuttle, and picker stick (their position and function was explained by means of pictures). From these two processes, spinning and weaving in particular, I would draw many

of my applications of Physics to textile manufacturing.

There are other textile processes of which mention should be made. Knitting, that process by which a single yarn instead of many is employed to form fabrics such as hosiery and knit underwear; Designing, that process which has to do with the choice of pattern, kind of weave and selection of color combination which will make the fabric attractive or useful to the buyer; Bleaching, that process through which all white fabrics must be put to remove the original grey color of the fibre; Dyeing, that process which colors the fibres when they are in any one of the following forms, raw stock, yarn, chain or cloth and lastly, Finishing, that process which gives cloth its final appearance, luster, thickness, smoothness or roughness, soft or hard feel, in fact, that process which makes the fabric finally ready for the consumer.

What are some of the applications of Physics to these processes? I shall not attempt to enumerate all of them, time does not permit; in fact, I may not use even the commonest illustrations because they are self evident, but some of the more unusual applications. You would naturally expect that the principles of kinematics, dynamics and mechanics would find wide application in these processes as it does in all others where machinery is used. Unlike some kinds of machinery, for example that used in the production of machine tools, textile machinery design is more a question of the application of motion of the right kind and properly timed than of large forces. It is clear from the pictures which you have seen that the spinning frame and loom are not heavily constructed, indicating that the forces are not very great.

Uniform Linear Motion

The equations expressing the relationships in this sort of motion find very wide application. Yarn is delivered from the front rolls of a spinning frame at a uniform rate and the amount delivered in a given length of time is a measure of its productivity. The production calculations of most of our textile machinery involve the principles of uniform linear velocity.

Uniform Angular Velocity

The same comments apply to this sort of motion for it is concerned with the revolutions per minute of driving

pulleys, of gears, of delivery rolls and hence closely related to the production of the machine.

Acceleration

A thorough understanding of the derivative relationship between acceleration, space and velocity, namely that

$$\text{Acceleration} = \frac{d^2s}{dt^2} = \frac{dv}{dt}$$

is important especially where motion is variable. No analysis of the motion of the lay of the loom would be complete without a determination of its acceleration at all points of its path. Such a determination is a necessary preliminary to the computation of the forces required to accelerate and retard it.

Harmonic Motion

The characteristic of harmonic motion, namely that it starts gradually and ends gradually, makes it exceedingly useful in the design of cams. The movement of the harnesses in a loom is accomplished by a cam, a part of whose outline gives harmonic motion to the harnesses. The guide in the French drawing box is operated by a slotted crosshead. Those familiar with such a mechanism know that it gives pure harmonic motion.

Gravity Motion

The uniformly accelerated character of this motion is particularly adapted for setting objects into motion from a state of rest. In a loom the motion of the picker stick is such that it gives uniformly accelerated motion to the shuttle as it starts on its path across the lay.

Work

An analysis of the work done during the spinning leads to two conclusions. A certain amount of work is usefully employed in twisting the fibres around each other, thereby compacting the yarn and giving it its strength. A larger portion of the work supplied is lost in frictional resistances and windage loss at the balloon.

Horse-power

This topic is always an important one whenever computations are to be made of the size of belts or motors which are necessary to drive textile machinery.

Energy

The passage of the shuttle across the lay of the loom

affords an interesting study of the relation between force and energy. Starting from rest the shuttle must receive during the very short time in which the picker stick is in contact with it, sufficient energy and velocity to travel across the lay. The time of its passage across the lay is exceedingly short being only a fraction of a second in the ordinary case. The resistances which it must overcome are largely the friction which is opposed to its motion and the drag of the filling thread which it is leaving behind. Provision must be made for absorbing the kinetic energy which it has as it enters the box towards which it is going.

Mechanical Efficiency

The ability of a machine to transform the largest proportion of the work which is delivered to it into useful form is always taken as an important measure of its value and effectiveness. It is always the aim of designers to produce machines of the highest efficiency. In modern textile machinery, therefore, we find an increasing use of ball and roller bearings for this very purpose since it substitutes rolling friction for sliding friction.

Friction

Friction is commonly thought of as a necessary evil where machinery is concerned but analysis shows that it serves many useful purposes. Were it not for the friction which is developed by twisting the fibres around themselves to form a yarn, the strand would have no strength. This is well illustrated by the ease with which the strand of roving, which has very little twist, is broken. In like manner the interlacing and intertwining of yarns to form cloth gives added strength to the fabric because of the friction developed between the strands. Friction is used to regulate the drag on bobbins in worsted spinning and is absolutely necessary in the drafting or drawing out processes in spinning. On the other hand, wool fibres are lubricated with an emulsion of olive oil and water to reduce the friction between them.

Triangle and Parallelogram of Forces and Motions

These invaluable principles for compounding or resolving forces or motions find many applications, for example, in determining the pivot reactions of bent levers.

Pendulum

The principle of the pendulum is commonly employed in

the design of machines for determining the strength of textile materials as will be illustrated later. The lay of the loom furnishes an interesting illustration of an inverted pendulum. If it is removed from the loom and suspended on knife edges its time of vibration can be determined and hence the length of an equivalent simple pendulum. If it is then taken and placed in a horizontal position on knife edge supports it is possible, by measuring supporting forces, to determine the location of its center of gravity. Knowing these two quantities and its weight it is an easy matter to compute its radius of gyration and hence determine its moment of inertia. Such determinations are incident and preliminary to the computation of the force required to accelerate the lay and consequently the forces which thereby act in the frame of the machine and some of which are transmitted to the floor.

Mechanical Principles

Mechanical principles find wide and varied uses in textile machinery. *Levers,* simple and compound, furnish a simple method for the weighing of rolls and many other uses. In making exact calculations their weights and centers of gravity must be determined. The principle of the *wheel and axle* is illustrated by the harness top rolls in a loom. Wherever ropes, bands or chains are used to transmit motion or force, as in a mule, we shall find the principle of *simple pulley blocks* involved. The principle of the *inclined plane* is employed to keep rolls in a given position by means of gravity. No machine can be constructed without employing the principle of the *screw* for purposes of fastening or for adjusting the position of parts with great nicety and exactness. Screws may be employed, as in the gill box, to give motion of translation to the fallers.

Heat

The use of heat in the generation of steam and the development of power through its expansion in engine or turbine is so well known as to require no further comment. Heat is commonly employed in the processes of dyeing and finishing for heating mixtures of textile fabrics with dyestuffs, chemicals, soap solutions or other finishing materials. Technical studies of these processes would involve a knowledge of the water equivalents of materials and the temperature of mixtures.

A detailed study of the use of heat for drying purposes will present many complex problems and involve a knowledge and understanding of the following: the conduction of the heat in the steam through the pipe to the air, its transmission by convection from air to the water in the fabric, the evaporation of this water into the air, the absorptive capacity of the air, the specific heats and rates of thermal conductivity of starches, glues and the textile materials themselves, the insulation of the walls of the dryer, and losses by radiation from it.

The physicist usually discusses the question of absolute humidity and relative humidity under the general topic of heat. The moisture content of the air is a matter of great importance to the textile man and I will reserve the discussion of it until later.

Electricity

The widespread use of electricity for light and power is such an obvious application that I pass on to other more obscure ones. Some textile machines are equipped with electrical stop motions, devices which act to stop the machine as soon as a thread or a yarn breaks. In this connection it is common to find magnets employed. Static electricity is an undesirable visitor in the operations of carding and weaving, particularly the weaving of silks and rayons. It is overcome by the use of neutralizers or by maintaining proper moisture conditions in the air.

Light

Under this heading comes its familiar application to color, and to those color combinations which make so many of our modern textile fabrics exceedingly attractive. To the dyer, the matching of colors is exceedingly important as well as a study of their fastness to light.

We come next to the discussion of the second phase of my topic, the measurement of the physical properties of textile fabrics. Under this heading I propose to tell you of the physical properties of textile fabrics in which we are interested and what methods have been developed for measuring them. Some are precision methods, some are not.

The outstanding characteristic of all textile fibres is that they are hygroscopic. They have the property of absorbing moisture from the air and appropriating it to themselves. The percentage absorbed may vary anywhere from

nothing to fifteen or twenty per cent according to the nature of the fibre and the atmospheric conditions. Whether a material will absorb moisture or give it off is merely dependent upon the relative magnitudes of the vapor pressure of the air in the fibres and the vapor pressure of the water in the air. If the latter is greater than the former the fabric will take on moisture and vice versa.

The presence of this moisture in a fabric is of great practical importance to buyers and sellers because it affects the weight. Since most textile fabrics are bought and sold on a weight basis, it is very vital that the buyer should know how much cotton or wool he is obtaining in his cloth and how much water he is paying for. This moisture likewise affects the strength of fabrics causing it to vary over a wide range according to the kind of material and the character and closeness of weave. It may interest you to know that cotton yarns vary as much as six per cent in strength for each per cent of regain (a term to be defined later).

For the purpose of determining the amount of moisture present conditioning ovens have been designed (see illustration). These are nothing more or less than chambers of suitable size thoroughly insulated and automatically maintained at the desired temperature electrically. Delicate balances are arranged on the oven so that the weights of samples may be obtained without removing them from the oven. The samples to be tested are placed in the oven and their natural weight obtained. They are then dried to a constant weight. This condition is recognized when two successive readings taken ten minutes apart vary no more than one-tenth of one per cent. The sample is now called bone dry. The difference between the bone dry weight and its original or natural weight represents the amount of moisture which has been driven off. The percentage which this moisture bears to the bone dry weight is known in textile terminology as the amount of regain of the fabric and is a most important quantity.

Recognition of regain and its effect upon the physical properties of fibres has necessitated the standardization of atmospheric conditions in testing laboratories. A standard atmosphere, therefore, is one in which the temperature is 70° Fahrenheit and which contains 65% relative humidity. To understand the relations between a standard atmosphere

and one which is not, involves an understanding of saturated and unsaturated vapors, vapor pressure, dew point, absolute humidity and relative humidity. It must suppose a knowledge of the common means of measuring relative humidity, for example, the use of various forms of hygrometers and psychrometers.

The production of any desired temperature and humidity conditions in a testing room is obtained by the use of apparatus known as humidifying or conditioning equipment. Various commercial forms have been designed and are on the market. For small rooms unit conditioners are available and are illustrated by the one which is now upon the screen. The principle of the mechanism which controls the humidity automatically is based upon the difference in temperature between the wet and dry bulb, or the wet bulb depression as it is commonly called.

For the same reasons as mentioned above, standards of condition of yarn and cloth have been adopted. A woven textile fabric is said to be in standard condition when it has been exposed for at least four hours to a standard atmosphere. On the other hand, yarn on bobbins is not considered to be in standard condition until it has been exposed to standard atmosphere for at least twelve hours. The longer time is necessary in the latter case in order that the moisture may penetrate more thoroughly into the tightly wound package.

For determining the tensile strength of textile materials there have been developed machines of the pendulum type the parts and the operation of which will be clearly seen in the illustration on the screen. These machines are built for a maximum capacity of 500 pounds for the vertical machine and up to 2,000 pounds for the horizontal. The angle of swing of the pendulum is kept preferably within 45° so that the rate of increase of load on the test specimen shall be fairly uniform. Jaws one inch and two inches wide and of a flat type are used for gripping fabrics. One inch diameter spools are substituted for the flat jaws for the testing of skeins.

There are two types of test specimens for fabrics, the strip and the grab. In the strip test a sample 1¼ inches by 7 is cut from the fabric and then raveled down to exactly 1 inch in width. This type of sample finds common use in

precision testing. For the grab test the size of the sample is 4 inches by 6 inches and is not raveled down. This type of specimen is generally used for commercial testing. The sample to be tested is placed in the jaws of the testing machine which are set at an initial distance of 3 inches apart. The speed of the straining jaw is commonly 12 inches per minute. Speeds of 6 inches and 3 inches a minute are specified for certain other types of tests. The samples are cut from the fabric in such a position that the strain is brought onto the warp or filling threads according to whichever set it is desired to test.

A high degree of variability in the physical properties of textile fabrics is quite common, in fact I might almost say is characteristic. In order to determine fairly the strength of a fabric, for example, there will arise the practical question of how many test specimens to use and from what locality they should be chosen. A proper answer to these questions is only found in a study of the principles governing the precision of measurements.

The elongation or stretch of the test specimens is best found by the use of stress-strain diagrams. These are autographically drawn by the testing machine itself. A typical form of these is illustrated on the blackboard. From them it is easily possible to determine the elastic stretch, and the crimp. These are usually expressed as a per cent. By measuring the area between the stress-strain diagram and the base line the amount of work required to break the fabric can be determined and this is a measure of its resiliency.

Three types of tests are used for determining the strength of yarns, the skein, single strand and multi-strand. The skeins are usually prepared by reeling from the bobbins a fixed length yarn. Lengths of 80 and 120 yards are common. They customarily consist of 80 wraps around a reel (like the one upon the table) whose perimeter is either 1 or $1\frac{1}{2}$ yards. When the skein is placed in the testing machine around the spools previously referred to, it is apparent that there are 160 strands resisting the applied load.

In the single strand test, as its name implies, the strength is determined by breaking single strands of the yarn. This is done in machines of the pendulum type but of very light capacity. For the multi-strand test a definite number of

strands, say 50 or 100, are carefully wound side by side on special jaws which retain them in this position after insertion in the testing machine. This is quite in contrast to the skein test which insures no exact parallelism of the strands when in the testing machine, nor equalization of the load amongst them.

The tension which is applied to a yarn while being reeled may seem to be an unimportant matter. It must not be overlooked, however, for it has a direct bearing upon the counts (which is the term used to designate the size) of a yarn. The effect of tension is to stretch the yarn and hence to affect the length of normal yarn which is wound onto the reel. It is from the weight of this standard reeled length that the size is determined.

In like manner the initial tension used in single strand tests to place the specimen under tension before the jaws are clamped is important. In this case it affects the stretch or elongation of the sample recorded by the machine. I mention these things merely to show that in precision testing no factor however trivial it seems to be, can be overlooked.

Lack of time does not permit an extended discussion of many of the other topics which I have prepared. I shall have to content myself with merely mentioning some of the other physical properties for which test methods have been devised. Standard apparatus is available and standard procedure has been adopted for determining the twist in yarns. The diameter of yarns can be determined by microscopic methods but the process is somewhat slow. We have in our laboratory a device which was designed by one of our own graduates, by means of which we can determine the thickness of yarns in a very rapid manner. It would be of interest to you because it involves simple optical methods.

If I remove a strand of yarn from this fabric you will observe its crimp. The percentage of crimp is a physical property of the fabric in which we are interested. A very interesting method is used for determining the amount of crimp. It involves the use of the chainomatic principle of weighting the strand and a careful measurement of the corresponding stretch by means of a linear comparator. From data thus obtained it is possible to construct a stress-strain diagram and an analysis of the diagram permits an

easy separation of the crimp from the elastic stretch.

We could easily spend an hour, if the time were available, on a discussion of various types of abrasion machines, machines which have been devised for measuring the abrasive resistance of fabrics and yarns, and of the many problems which arise. Tests have been developed for measuring the tear and resistance of cloth. At the meeting of the American Society of Testing Materials in Charlotte, in March last, there was demonstrated a very interesting machine known as the flexometer. This has recently been developed by the Bureau of Standards and is for the purpose of measuring the resilience and stiffness of textile materials, and hence their draping effects.

Usefulness of fabrics used for gas masks, filter cloths, parachutes and balloons depends in part upon its porosity. Methods are in use for measuring even this physical property of a fabric. Closely allied to this problem is that of determining the waterproofness of such cloths as enter into the construction of rain coats, umbrellas, etc.

The heat conductivity of blankets, felts and all wearing apparel you will at once recognize as an important and interesting physical property. Its measurement is merely an application of the principles of calorimetry with which you are all familiar. Color, as I previously indicated, is one of the most important branches of Physics in which the Textile Industry is interested. To eliminate the personal equation in the matching of colors there have been devised various forms of colorimeters. The most recent and the most interesting of these is probably that of Professor Hardy of the Massachusetts Institute of Technology. This machine not only analyses the color but makes an autographic record of it. We tried to secure one of these machines that we might demonstrate it today but unfortunately we were unable to obtain one. We shall, however, be able to show you what we are doing here in our own laboratory in the way of measurement of the luster of fabrics. This is a problem upon which we have been working for several years and its solution we believe to be near.

Much time could be spent discussing the part played by that most important physical instrument, the microscope, in the recognition of fibres and fabrics and a study of their physical characteristics. The use of the spectrophotometer

for the identification of dyestuffs and for the determination of their concentration and purity by spectral absorption is an interesting application of the principle of the spectroscope. The employment of polarized light and X-rays for the study of fibres and the determination of the character of their structure is finding a wider and wider application. Even oscillatory circuits lend their aid to the study of these physical properties of which we speak. In our own laboratory we are experimenting with them in the hope of obtaining a sensitive instrument for measuring the variation in density of textile materials and I think its use can be extended to the measurement of their moisture content.

If the latter part of this talk has seemed sketchy it is merely because of the lack of time and the breadth of my subject. If, however, I have made you realize how many physical properties of textile materials we have to measure and have shown you the widespread use of the fundamental principles of Physics by which it is accomplished, then the purpose of my talk will have been accomplished. I thank you for the opportunity of presenting this material to you.

Note: This lecture was illustrated with lantern slides and demonstrations.

REPORT OF THE APPARATUS COMMITTEE.

The chairman, J. C. Packard of Brookline, Mass., suggested that, in order to stimulate invention and discovery on the part of the teachers themselves, the members of the Association make it a point to bring in simple devices of their own construction rather than the more elaborate pieces shown by the manufacturers.

Contributions.

From T. A. Pickett of the School of Mechanic Arts, Boston, Mass.

For Determination of Density and Specific Heat.

A. Four cylinders, 1 in. x 2 in.,—"of equal volumes but of different materials"—made of aluminum, brass, and Babbitt metal, respectively.

B. A single cylinder representing the weight of an equal volume of water.

C. Three cylinders, one of iron, one of brass and one of Babbitt metal, each one the equivalent, in weight, of the aluminum cylinder.

Demonstration.

1. Relative Densities.
   (a) By comparing weights of equal volumes.
   (b) By comparing volumes of equal weights.
2. Actual Densities.
   (a) By loss in weight method.

(b) By gain in weight method.

3. Archimedes' Principle.
Loss of weight depends upon the volume of the displacing body and not upon its weight. Counter balance a beaker of water: add the cylinder B to the weights upon the scalepan. Suspend each of the cylinders A in turn in the beaker of water and observe that the balance is restored in each case. Conclusion?

4. Specific Heat.
(a) By the ordinary method.
(b) By comparing depth hot metal sinks in paraffine.

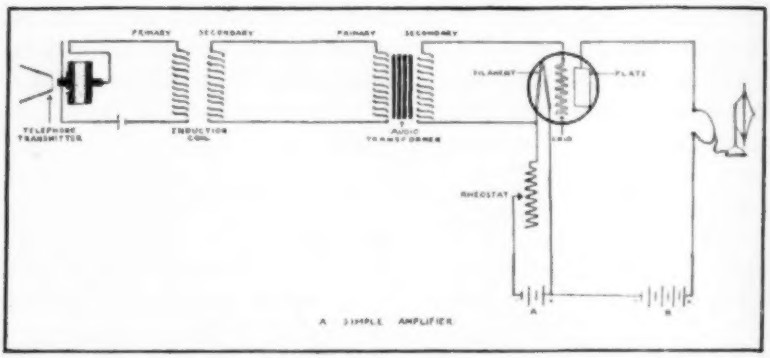
To Illustrate Atmospheric Pressure.

A glass tube of large bore, thirty inches or more in length, painted white on the back for visibility, and closed at one end. A test tube made to fit rather loosely inside the glass tube and painted green for contrast.

Experiment. Fill the glass tube with water: insert the test tube open end outward, and invert the apparatus over the sink. As the water runs out the test tube mounts steadily upward, inside the long tube, and, finally, bumps against the closed end at the top, Explain fully.

From J. E. Corcoran of the Brookline High School.

As an Introduction to the Radio.



A SIMPLE AMPLIFIER

A compact audio frequency amplification set, the input being represented by a long distance telephone transmitter of simple design, coupled to a small induction coil, in lieu of a "mike," and the output by a magnetic loud speaker. The whole mounted in three sections upon a hard rubber base with the various circuits clearly marked out in distinct colors of spaghetti.

In practice the transmitter is placed in an adjoining room, after the apparatus has been shown to the pupils, and the "news of the day" detailing the wonders of the radio, is delivered from that point, giving the effect of a real transmitting and receiving station, while illustrating in fact the actual apparatus and the method of amplifying the speaker's voice in an up-to-date assembly hall or in the various rooms of a modern High School building.

A fine piece of apparatus and an excellent introduction to an explanation of the fundamental principles underlying the action of the common radio receiving set.

From Mr. Packard

To Illustrate Archimedes' Principle.

An adjustable Cartesian diver, consisting of a small electric lamp, of the Christmas tree order, having an extension tube soldered around the base with a hollow plug screwed into one end. The apparatus having been previously balanced in water at room temperature, the screw is turned in or out until the displacement meets the requirements of flotation desired. It may be made to sink in warm water and to rise in cold water or to remain suspended at point of greatest density in a variable salt solution, as one may desire.

For Display of Ultraviolet Rays.

A simple arc lamp made by inserting a pair of carbon rods—3/16 in. in diameter—through two brass tubes piercing the opposite sides of a square tin can and soldered in place in such a manner that the can acts as a lamp stand and at the same time serves to prevent the possible escape of any ray of white light into the surrounding lecture room. In practice the lamp is to be connected in series with a toaster or a flatiron on a 110-volt line.

Experiment. (In the darkened lecture room.)

A plate of heavy black glass, impervious to visible light but transparent to ultraviolet rays, is placed over the open end of the can and the light is turned on, by bringing the carbon rods together inside the can. Nothing is seen until a small beaker of kerosene or a block of uranium glass is placed over the glass plate, when the instant fluorescence of the liquid, or of the solid, reveals the presence of the ultraviolet rays in a most spectacular manner.

The only objection to the apparatus is the annoyance caused by the heat from the enclosed arc-lamp. This can be offset in part by immersing the apparatus in ice water or by a system of ventilation, care being taken not to allow the escape of too much white light into the room. The objection is not serious however if the experiment is hurried a bit and the light is turned on at intervals instead of being kept at a constant glow.

Transmission.

A rear end assembly was shown which had been made from the parts of a meccano set, by one of the boys of a Junior Class to explain the action of the differential.

The address by Prof. A. Edwin Wells of the Lowell Textile Institute upon the "Measurement of Color and Lustre as applied to Textile Fabrics" was a very interesting paper. It touched upon various interpretations of lustre and the necessity for establishing standards. We were privileged to hear about some conclusions very recently established which promise light upon many of the problems involved. Several experimental demonstrations were shown to make points clear.

A full account of this address will appear in the next issue of this magazine.

W. W. OBEAR, *Secretary.*

A great deal of the joy of life consists in doing perfectly, or to the best of one's ability, everything which he attempts to do.—William Matthews.

SCIENCE QUESTIONS

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

WHAT SHALL WE DO THIS YEAR?
Suggestions, please. Thanks! The Editor.

EDISON SETS HIGH STANDARD.

Thomas A. Edison again awards a scholarship on the basis of an examination.

The examination is in Three Parts. Part one only is published in this number of School Science and Mathematics. Do you want to see Parts II & III?

562. *Comments on Edison's 1930 Questions.*

Please solve and send in answers for the questions in chemistry and Physics. Try these questions on your pupils before they have studied Chemistry or Physics.

If you wish, sign your answer by an assumed name but give me your true name and address.

Propose some questions for Edison to use next year.

563. *For comparison the questions set by the College Entrance Examination Board in June are also published. Comments are desired.*

EXAMINATION, EDISON SCHOLARSHIP AWARD, PART ONE

Questions in Chemistry, Mathematics, and Physics

Time—two hours and fifteen minutes.
(Allow approximately nine minutes for each question)
West Orange, N. J., 31 July, 1930

Chemistry.

Answer Five Questions.

1. What container would you select for storing each of the following substances? State what special precautions should be observed in each case. (a) Sodium, (b) White phosphorus, (c) Hydrogen. (d) Hydrogen peroxide. (e) Hydrofluoric acid.

2. State Avogadro's hypothesis and show how it is used by Chemists in the determination of molecular weights.

3. Mention by name and formula the substances required for a laboratory preparation of each of the following: (a) Nitric acid. (b) Ammonia, (c) Chlorine. Describe briefly the procedure in the laboratory preparation and collection of *one* of the foregoing substances.

4. (a) When MnO_2 is heated strongly it evolves oxygen, forming Mn_3O_4. Write a balanced equation for the change. (b) and (c). Why is alcohol used in the radiator of an automobile in winter? Which is more effective, a pound of alcohol, C_2H_5OH, or a pound of sugar, $C_{12}H_{22}O_{11}$? Why?

5. Suggest a method which might be used for producing pure silver from a silver coin.

6. Make a brief statement defining the meaning of each of the following terms: (a) Combining weight. (b) Density. (c) Atom. (d) Heat of reaction. (c) Valence.

Mathematics.

Answer Five Questions.

1. Solve and check by a graph,

$$\left.\begin{array}{r} xy=9 \\ 3x-4y=12 \end{array}\right\}$$

2. (a) An elastic ball bounces to ¾ of the height from which it

falls. If it is thrown up from the ground to a height of 15 feet, find the total distance traveled before it comes to rest.

(b) Find the 4th term in the expansion of $(x\sqrt{2}-\sqrt[3]{3})^6$.

3. A man has two solutions of a certain chemical in water, one containing 50 per cent. of the chemical by weight and the other 10 per cent. He wishes to obtain 80 grams of solution containing 25 per cent. of the chemical. How much should he take of each of the solutions he has?

4. The base of a pyramid is a square each side of which is 12 inches, each of the other four edges is 20 inches. Find the altitude and the volume of the pyramid.

5. (a) A triangle is divided into three parts by lines drawn parallel to the base and trisecting the altitude. Find the ratio of the area of each part to the area of the triangle.

(b) From a point P at a distance of 4 feet from the center of a circle of radius 2 feet, tangents are drawn. Find the area bounded by the tangent lines and the convex portion of the circle. (The result need not be simplified).

6. (a) Simplify: $(r^{\frac{1}{3}}+s^{\frac{1}{3}})\ (r^{\frac{2}{3}}-r^{\frac{1}{3}}s^{\frac{1}{3}}+s^{\frac{2}{3}})$

(b) and (c) A, B or C could complete a piece of work in 10, 12, or 14 days respectively working alone. They work on the task together for two days when A stops and at the end of the third day B stops. How long will it take C to finish?

PHYSICS.

Answer Five Questions

1. (a) Why is the energy of a rifle bullet greater than that of the gun from which it is fired?

(b) Under what conditions may a force act continuously on a moving body and still do no work?

(c) Distinguish clearly between work and power.

(d) Explain how the water line of a boat would be affected if its lead keel were taken off the outside and placed inside the boat.

2. Two wires, having a resistance of 2 and 4 ohms respectively, are connected in parallel across the terminals of a 6 volt battery having an internal resistance of 1/6 ohm.

(a) What is the current through the battery?

(b) What is the potential difference between the battery terminals?

(c) At what rate is energy being dissipated by the 4 ohm wire? (Give answer in watts).

3. (a) Why does a magnifying glass of short focus give greater magnification than one of longer focus?

(b) Why is greater magnification obtained in a telescope whose objective lens has a focus of 2 feet than in one with an objective of 1 foot focus?

4. (a) What is the difference between noise and musical sounds?

(b) If a Church organ is not provided with some sort of heating arrangement it will play out of tune when the Church is cold. Explain.

(c) What is the smallest height mirror standing vertically in which a man 6 feet tall and standing erect can see his entire length?

5. (a) Define coefficient of friction; dyne; microfarad.

(b) Aluminum is claimed to be a very superior substance for cooking utensils. What are the physical properties which are in favor of or against such use?

6. (a) What is heat?

(b) What is meant by absolute zero?

(c) Define coefficient of expansion.

(d) If a hole in a metal plate is 3 inches in diameter at a temperature of 20°C., what will be its diameter at a temperature of 30°C., if the linear coefficient of expansion of the metal is 0.00001?

563. COLLEGE ENTRANCE EXAMINATION BOARD—1930.

(Comments are desired.)

This paper must be returned by the candidate with his answer book.

PHYSICS.

Wednesday, June 18, 1930 *2 p. m. Two hours*

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

State the units in which each answer is expressed.

No credit will be given for problems on this paper unless the methods of reaching the results are clearly shown.

Number and letter each answer to correspond with the questions selected.

PART I.

(Answer all questions in this part.)

1. Distinguish between the two terms in each of the following pairs:
 (*a*) Work and power
 (*b*) Velocity and acceleration
 (*c*) Density and specific gravity
 (*d*) Force and moment of force
 (*e*) Center of gravity and center of volume

2. A plank 12 feet long reaches from the ground to a truck 3 feet high. A force of 35 pounds must be applied parallel to the plank to pull a 100-pound bag of potatoes up the incline.
 (*a*) Compute the efficiency.
 (*b*) Compute the force of friction.

3. A gas tank is 5 feet high and 0.25 square feet in inside cross-section. The pressure of the gas within is 885 pounds per square inch by the gauge.
 (*a*) Calculate the volume of gas measured at atmospheric pressure (15 pounds per square inch) which can be taken from the tank.
 (*b*) Name the man who discovered the principle involved in the solution of this problem.

4. Answer the following questions and state the physical principles involved in each case:
 (*a*) Why is a radiator a necessary part of an automobile engine?
 (*b*) Why is water used in so many automobile radiators?
 (*c*) Why is some other liquid often added to the water in a radiator in cold weather?
 (*d*) What are the reasons for the peculiar designs of automobile radiators?

5. Two electric lamps, each having a resistance of 220 ohms, and an electric fan which takes 4 amperes, are all three connected in parallel on a 110-volt circuit.
 (*a*) Show by means of a diagram how these are connected.
 (*b*) Compute the total cost per hour of running these at 8 cents per kilowatt-hour.

6. A stone is dropped vertically into a pond of still water. It is observed that when ten circular crests have started outward, the outer one has a radius of 6 meters. During 40 seconds eight crests pass a certain point. Compute (*a*) the wave length; (*b*) the velocity of the wave; (*c*) the frequency of the waves.

7. By five drawings and a brief explanation of each, show how a ray of light may be (*a*) reflected, (*b*) refracted, (*c*) dispersed, (*d*) diffused, (*e*) diverged.

PART II.

(Answer three questions from this part)

8. (*a*) How could you find the "pick-up" or acceleration of an automobile which has a speedometer?

(*b*) In what units would your answer be expressed?

(*c*) Compare the distances required for stopping an automobile going at a speed of 20 miles per hour and 40 miles per hour, assuming the same braking-force applied in each case. Show your reasoning.

9. Each end of a rope 10 feet long is fastened to a hook in a ceiling. The hooks are 8 feet apart, and a weight of 300 pounds is hung from the middle of the rope.

(*a*) Find the pull on each hook.

(*b*) How would it affect the pull on the hooks if the rope had been shorter? Give your reasoning.

10. If the fuel value of a certain grade of gasoline is 90,000 B.T.U. per gallon, how efficiently is the gasoline used if 1 gallon will drive a car 30 miles against an opposing force of 100 pounds? (One B.T.U. = 778 foot-pounds.)

11. An electric range is supplied with current from a 112-volt circuit. The range takes 4 amperes.

(*a*) Calculate the resistance of the range.

(*b*) How long would it take to heat 1,000 grams of water from 15° C. to the boiling-point if 80 per cent of the heat is utilized?

12. State whether only alternating current or only direct current, or either, may be used in each of the following. Give a reason for each answer:

(*a*) Charging a storage battery
(*b*) Incandescent lighting
(*c*) Operating a transformer
(*d*) Producing the magnetic field in a shunt-wound generator
(*e*) Electroplating

13. Two boys, *A* and *B*, take from the same point pictures of an object 50 centimeters long and 1 meter from their cameras. *A* uses an expensive camera, with appropriate fittings, including a high-speed lens of focal length 20 centimeters. *B* uses a home-made camera, in reality little more than a pinhole in one end of a box 25 centimeters long. Find the length of the image in each case.

14. (*a*) Draw a diagram of a simple spectroscope, showing a slit, a lens, and a prism for observing the spectrum of an incandescent lamp.

(*b*) How does the spectrum of a tungsten lamp differ from that of a mercury-vapor lamp?

(*c*) Will the Fraunhofer lines be seen in either case? Explain.

15. Name one person in each case whose work in physics is connected with each of the following topics: (*a*) absolute zero; (*b*) barometer; (*c*) dispersion; (*d*) electric waves; (*e*) electromagnetic induction; (*f*) electron; (*g*) inertia; (*h*) radium; (*i*) steam engine; (*j*) velocity of light.

563. COLLEGE ENTRANCE EXAMINATION BOARD—1930.

(Comments are desired.)

This paper must be returned by the candidate with his answer book.

CHEMISTRY.

Tuesday, June 17, 1930 *2 p. m. Two hours*

Answer EIGHT questions as indicated below.

Number and letter your answers to correspond to the questions selected.

No credit will be given for problems on this paper unless the methods of reaching the results are clearly shown.

PART I.

(Answer all five questions.)

1. Each of the following statements presents a fact which conforms to an important general law of nature. Give a complete statement of the law in each case, and give the name by which the law is usually known.

(*a*) Eighteen parts by weight of pure water, whatever its source, always contain sixteen parts by weight of oxygen.

(*b*) The quantity of gas which would fill a tank of 50 cubic feet at atmospheric pressure would at the same temperature just fill a tank of 25 cubic feet at two atmospheres pressure.

(*c*) There are two oxides of copper. In the black oxide 16 grams of oxygen are combined with 63.6 grams of copper, whereas in the red oxide 8 grams of oxygen are combined with 63.6 grams of copper.

(*d*) Exactly two volumes of pure oxygen are required to react completely with one volume of methane.

2. (*a*) What weight of magnesium nitride could be obtained by heating 12.15 grams of magnesium in pure dry nitrogen?

$$3Mg + N_2 \rightarrow Mg_3N_2$$

(*b*) What volume of nitrogen measured at standard temperature and pressure would be used?

(*c*) What volume of dry ammonia at 760 mm. and 0° C would be given off if the magnesium nitride obtained in (*a*) reacted with just the weight of water required by the equation:

$$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3?$$

(Atomic weights: Mg=24.3; N=14; H=1; O=16. Gram molecular volume=22.4 liters.)

3. Two clear colorless liquids are poured together and a white precipitate forms which soon settles, leaving a clear colorless liquid above it. Write equations, avoiding duplication of any radical, for three different reactions, each of which would produce the effects described above. Indicate the formula of the insoluble substance in each equation.

4. Starting with the first-named substance, in each of the following cases tell briefly how you would proceed to form the second. Give one method only in each case; write equations for all reactions:

(*a*) Concentrated sulphuric acid to form sulphur dioxide;
(*b*) Carbon dioxide to form calcium carbonate;
(*c*) Common salt to form chlorine;
(*d*) Air to form nitric acid.

5. Define the following terms, giving an example in each case to illustrate the definition:

(*a*) synthesis; (*b*) acid anhydride; (*c*) deliquescence; (*d*) allotropy; (*e*) neutralization.

PART II.

(Answer any three questions. If answers to more than three are given, only the three that appear first will be considered.)

6. (*a*) Name four substances produced commercially by means of the electric furnace.

(*b*) Describe the process of making one of these substances, giving a diagram of the furnace.

(*c*) Give at least one important use for each of the four substances named.

7. (*a*) What volume of dry hydrogen chloride (measured under standard temperature and pressure) would be required to react exactly with 125 cc. of 0.4 molar $AgNO_3$ solution?

(*b*) What weight of silver chloride would be obtained?

(Atomic weights: Ag=108; N=14; O=16; Cl=35.5; H=1, Gram molecular volume=22.4 liters.)

8. If you had the following substances in the form of dry powders, describe carefully tests by which you would identify both radicals of each one. Give equations for all reactions involved in the tests:

(*a*) potassium iodide; (*b*) ferrous sulphide; (*c*) ammomium nitrate.

9. Write ionic equations for the reactions between the pairs of substances in *a*, *b*, and *c*. Note after each reaction whether or not there is a visible change, and if there is, describe it:

An Ideal D. C. Instrument *for* School Laboratories

Pattern 41 Features:

1. Accuracy guarantee of 1%.
2. Excellent scale illumination.
3. A 3-5/16" scale length—30% longer than afforded by instruments of comparable size and accuracy.
4. Case of moulded bakelite.
5. Binding posts moulded in bakelite prevent damage to internal connections.
6. Rugged, sturdy construction which makes it a favorite for school use.
7. Shielded from influence of external magnetic fields.

Widely Used in Industrial Service

Much of the popularity of the Jewel Pattern 41 D. C. Pocket Portable Instrument can be attributed to the extra long scale and special magnetic shielding which combine to increase its accuracy.

The sturdy one piece body of moulded bakelite is another feature that has met with universal approval.

The movement has been proved by years of service in small instruments.

The moving element is swung on sapphires and has a resistance of 80 ohms or more per volt.

The binding posts, moulded in bakelite, are favorites in classrooms, because they prevent injury of internal connections by careless students.

Every school laboratory should have a liberal supply of Jewell Pattern 41's. Write for additional data and prices.

Jewell Electrical Instrument Co., 1650 Walnut St., Chicago, Ill.

Manufacturers of a complete line of high grade A. C. and D. C. instruments, including switchboard instruments from 2" to 9" in diameter, and portable instruments from small pocket sizes to laboratory precision standards.

30 YEARS MAKING GOOD INSTRUMENTS

JEWELL

JEWELL

(a) Ammonium hydroxide solution and nitric acid solution;
(b) Zinc and silver nitrate solution;
(c) Ammonium sulphide solution and zinc nitrate solution.

State under *d* and *e* two outstanding differences in properties between electrolytes and non-electrolytes in aqueous solutions.

10. Outline, with the aid of a diagram, the industrial process of obtaining aluminum.

11. Comment on the value of the Periodic Classification of the elements. Mention specific elements in presenting the points of your answer. What advantages do atomic numbers have over atomic weights as a basis of the classification?

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

SOLUTIONS OF PROBLEMS.

1115. *Proposed by I. N. Warner, Platteville, Wis.*

A right circular cone of altitude 10 in. and radius of base 6 in., is cut by a plane through the vertex making a section equal in area to only one-half of the area of the largest possible section through the vertex. How far from the center of the cone's base does this section cut the base?

Solved by E. A. Hollister, Pontiac, Mich.

The largest section would be made by a plane through the center of the base, and the area of this section would be 60 sq. in. Hence the area of the required section would be 30 sq. in.

Let x be the distance from the center of the base at which this section cuts the base. The section thus made would have a base whose length is $2\sqrt{36-x^2}$ and whose altitude is $\sqrt{100+x^2}$. Then $\sqrt{(36-x^2)(100+x^2)}=30$, and $x=5.38$ in.

Also solved by *John Kuzma, W. E. Buker, Leetsdale, Pa.; Raymond Huck, Johnston City, Ill.; R. T. McGregor, Elk Grove, Calif.; Louis R. Chase, Newport, R. I.;* and *Tillie Dantowitz, Philadelphia, Pa.*

1116. *Proposed by Norman Anning, University of Michigan.*

Find the angles satisfying this equation:

$$\sin^3X - \sin X = \sin^3 18^\circ - \sin 18^\circ$$

Solved by Francis P. Hennessey, Jamaica Plain, Mass.

Re-arranging, then dividing both members of the equation by $\sin X - \sin 18^\circ$, gives

$(\text{Sin}X - \sin 18^\circ)\ (\sin^2X + \sin X \sin 18^\circ + \sin^2 18^\circ - 1) = 0.$

From the first factor it is evident that 18° is a solution. From the second factor we get $\sin X = .809$. Hence, $X = 54^\circ$ or 126°. Knowing these three angles, it is not difficult to find the general expression for all angles satisfying the equation.

Also solved by *Louis R. Chase, Newport, R. I.; Raymond Huck, Johnston City, Ill.; E. A. Hollister, Pontiac, Mich.; Marge Joseph, Milwaukee, Wis.; Tillie Dantowitz, Philadelphia, Pa.; and the Proposer.*

1117. *Proposed by H. D. Grossman, Brooklyn, N. Y.*

Given triangle ABC with angle bisectors BR and CS. Drop perpendiculars AU on BR and AV on CS. Then UV is parallel to BC.

LEITZ

New School Microscopes

Model "LL"

Aside from the Leitz Microscopes being endowed with superior mechanical and optical features,

the Model "LL" is now furnished with a stand of enlarged design and extreme ruggedness.

The culmination of such features assures any school of the best serviceable equipment when a Leitz Microscope is selected.

The prices for these new constructions have not advanced; they range, depending upon the equipment, *from \$47.75 to \$113.50.*

We grant a 10% discount to educational institutions.

Write For Pamphlet No. 1168 (SS)

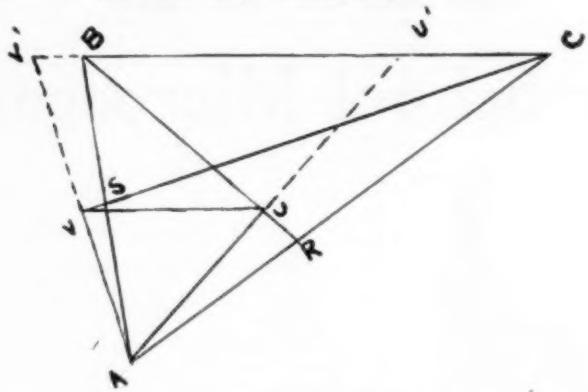
E. LEITZ, Inc.

60 East 10th St. **New York, N. Y.**

BRANCHES:

Pacific Coast States: Spindler & Sauppe, Offices at San Francisco and Los Angeles, Calif. Chicago District: E. Leitz, Inc., Peoples Gas Bldg., Chicago, Ill. Washington District: E. Leitz, Inc., Investment Bldg., Washington, D. C.

Solution I. Tillie Dantowitz, Philadelphia, Pa.



Extend AV to meet CB in V'; AU to meet CB in U'.

Since AV is $\perp$ to CV, and CV bisects $\angle$ACV', triangle ACV' is isosceles and AV = VV'.

Since AU is $\perp$ to BR, and BU bisects $\angle$ABU', triangle ABU' is isosceles and AU = UU'.

Hence, VU is parallel to V'U', for VU joins the midpoints of the two sides of the triangle V'AU'.

Solution II. W. E. Buker, Leetsdale, Pa.

Draw VP and UQ perpendicular to BC.

Now, triangle BAU is similar to triangle BUQ (rt. triangle, each having an angle equal to $\frac{B}{2}$).

Let AB = c; AC = b.

Then, $AU = c\sin\frac{B}{2}$; $BU = c\cos\frac{B}{2}$

$\therefore UQ = C\cos\frac{B}{2}\sin\frac{B}{2} = \frac{1}{2}c\sin B$ (1)

Also, triangle CAV is similar to triangle CVQ (rt. triangle, each having an angle equal to $\frac{C}{2}$)

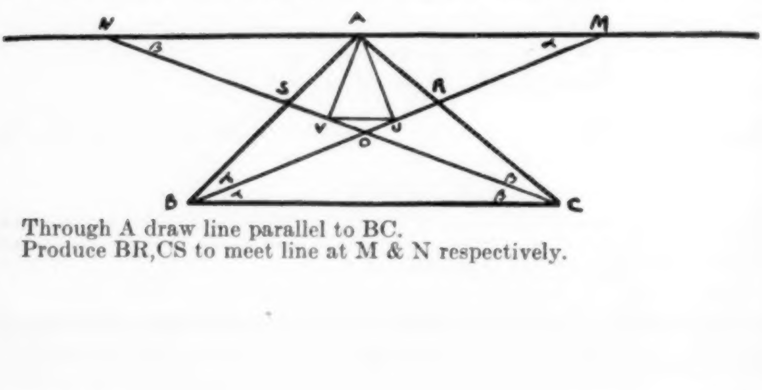
Then, $AV = b\sin\frac{C}{2}$; $CV = b\cos\frac{C}{2}$

$\therefore VP = b\cos\frac{C}{2}\sin\frac{C}{2} = \frac{1}{2}b\sin C$ (2)

By the law of Sines, $b\sin C = c\sin B$

$\therefore$ UQ = VP. So, since UQ and VP are perpendicular, UV is parallel to BC.

Solution III. H. W. George, Medicine Hat, Alberta, Canada.



Through A draw line parallel to BC.

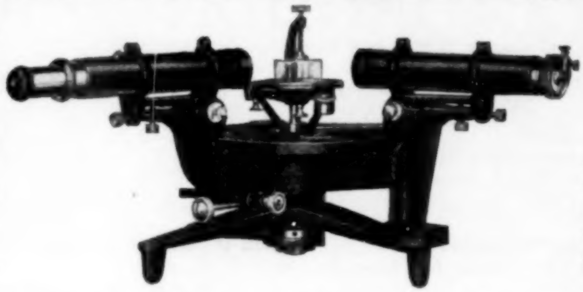
Produce BR,CS to meet line at M & N respectively.

SPENCER SPECTROMETER No. 10025

Complete

$110

10% discount to Schools



Designed by a physicist for use in Physics Laboratories of Universities, Colleges and High Schools

It's built low and compact, cannot upset, and rugged enough to withstand the usage in student laboratory and still maintain its adjustments.

Circle is graduated to half degrees on a brass disc that has been finely tempered and will not warp. The verniers read to single minutes, rotating on same level as the circle graduations, thus eliminating parallax. The circle and verniers are enclosed in a dust tight cover having glass windows.

Literature and quotations upon application.

SPENCER BUFFALO U.S.A.

SPENCER LENS COMPANY
Buffalo, N. Y.

Branches:
New York, Chicago, Boston, Washington, San Francisco, Los Angeles, Minneapolis

SPENCER BUFFALO U.S.A.

THE INSTRUCTOR

who appreciates quality and thoughtful design will find in this dual-purpose table, a worthy assistant. The arrangement of cupboard and reagent space close at hand makes this table ideal for use in both Chemistry and Physics.

Instructor's Table No. 1205
For Chemistry and Physics

Catalog No. 16-D will show the complete Peterson Line of fine Laboratory furniture.

LEONARD PETERSON & CO., INC.

Manufacturers of Guaranteed Laboratory Furniture

OFFICE AND FACTORY

1222-34 Fullerton Avenue — **Chicago, Illinois**

New York Sales Office: Knickerbocker Bldg., 42nd and Broadway

Angle MBC = angle NMB and angle NCB = angle MNC.

$$\frac{NO}{OC} = \frac{MO}{BO} \text{ or } \frac{NO}{OC+NO} = \frac{MO}{BO+MO} \qquad \text{.......... (1)}$$

Triangle NAC is isosceles; AV is perpendicular to NC

$OC + NO = 2\ NV$ .... (2)

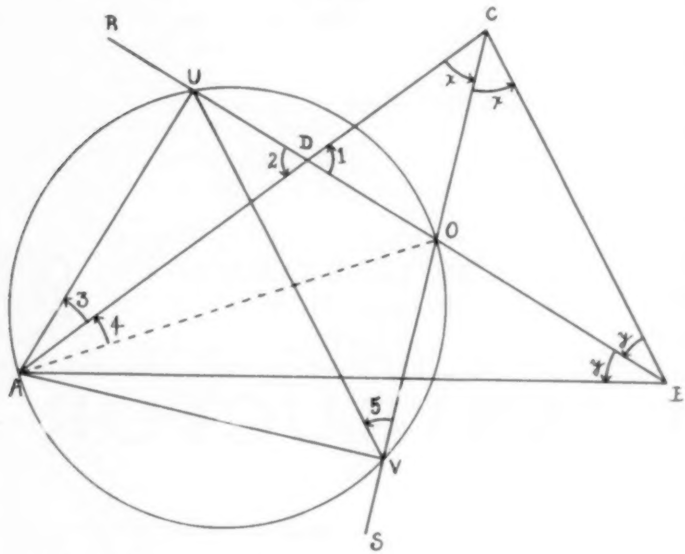
In like manner; $BO + MO = 2\ MU$ .... (2)

Substituting 2 in 1. & multiplying by 2, we get

$$\frac{NO}{NV} = \frac{MO}{MU}$$

Therefore; VU is parallel to MN which is parallel to BC.

Solution IV. Louis R. Chase, Newport, R. I.



Draw AO. AO bisects angle BAC, since O is in-center of triangle ABC.

Angle 2 = angle 1 = $180° - 2x - y$. (From triangle DBC)

Angle 3 = $90°$ − angle 2 = $2x + y - 90°$. (From triangle ADU)

Angle 4 = $\frac{1}{2}(180° - 2x - 2y) = 90° - x - y$. (From triangle ABC)

Therefore angle 3 + angle 4 = angle x.

Since angles AUB and AVC are right, A, V, O, U are concyclic.

Therefore angle 5 = angle 3 + angle 4 = angle x.

Therefore UV is parallel to BC. (Alternate-interior angles are equal.)

Also solved by *S. L. Feduska, Leetsdale, Pa.; E. A. Hollister, Pontiac, Mich.; R. T. McGregor, Calif.; and A. J. Paull, Chicago, Ill.*

1118. *Proposed by John J. Kinsella, Monticello, N. Y.*

Simplify:

$$\left[\sqrt[4]{\left(-\tfrac{8}{27}\right)^{-\frac{1}{3}}}\right]^{-\frac{4}{3}}$$

Solved by Hazel Fliess, Clifton Forge, Va.

Using fractional exponents, the original expression may be written

$$\left(-\tfrac{2}{3}\right)^{(3)\left(-\frac{1}{3}\right)\left(\frac{1}{4}\right)\left(-\frac{4}{3}\right)} = \left(-\tfrac{2}{3}\right)^{\frac{1}{3}} = \tfrac{1}{3}\sqrt[3]{-18}$$

Evaluating, we get $-.87$.

Editor: By proper consideration of exponents, a positive result of .87 may be obtained.

Also solved by *Betty Deveraux, Germantown, Pa.; Tillie Dantowitz, Philadelphia, Pa.; Sudler Bamberger, Harrisburg, Pa.; W. E. Buker, James Loughman, Leetsdale, Pa.; Marge Joseph, Milwaukee, Wis.; Alice Barkhuff,*

PLANE TRIGONOMETRY

A New Textbook

By

THOMAS MARSHALL SIMPSON, PH.D.

HEAD, DEPARTMENT OF MATHEMATICS, UNIVERSITY OF FLORIDA

PLANE TRIGONOMETRY was developed from a course given for several years from mimeographed material. During this trial period, practice tests were freely used to determine which topics are most difficult for students, and which methods of presentation are easiest and clearest. As a result the book is truly a "student's book" and not just a "teacher's book"—explanations are so clear and simple that the student cannot fail to understand. College Entrance Examination Board requirements are fully covered, and there is careful preparation for future mathematical needs.

THE JOHN C. WINSTON COMPANY

Chicago **PHILADELPHIA** **Atlanta**

The Geography of the Heavens

Twenty-four lantern slides and a copy of Storrs B. Barrett's 40 minute lecture—especially suitable for presentation to high-school classes.

The slides are a special selection from those issued by Yerkes Observatory, Williams Bay, Wisconsin. They are reproduced from original astronomical photographs, many of which were made with the 40-inch refracting telescope, the largest of its kind.

Slides and lecture may be rented for $3.00 for each occasion, plus postage, or purchased for $15.50.

The Technique of Teaching Mathematics in Secondary Schools

By ERNST R. BRESLICH

The athuor of the well-known unit plan mathematics texts in this book has diagnosed the problems of choice of materials, procedures, devices, and general classroom management. *$2.00.*

THE BRESLICH TEXTS

SENIOR MATHEMATICS Book I. $1.40

SENIOR MATHEMATICS Book II. $1.40

SENIOR MATHEMATICS Book III. $1.55

SOLID GEOMETRY $1.55

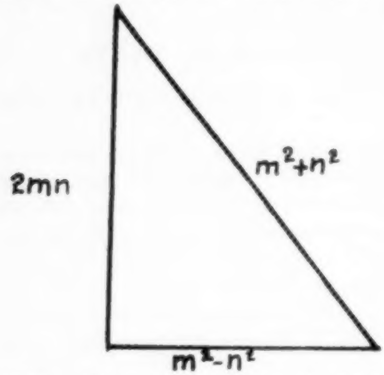
TRIGONOMETRY By Breslich and Charles A. Stone. $1.65

CORRELATED MATHEMATICS FOR JUNIOR COLLEGES. $1.40

THE SLIDE RULE By Breslich and Stone. 50 Cents

THE UNIVERSITY OF CHICAGO PRESS

Cathlamet, Wash.; A. J. Richiardi, Chicago, Ill.; Charles Wilcox, Greenwich, Conn.; Francis Hennessey, Jamaica Plain, Mass.; Elizabeth Wilson, Bentonville, Ark.; Billy Kelsey, Willis Parott, Mason City, Iowa; Raymond Huck, Johnston City, Ill.; E. A. Hollister, Pontiac, Mich.; R. T. McGregor, Elk Grove, Calif.; and Floyd Sheel, Assaria, Kansas.



1119. *Proposed by the Editor.*

Prove: The area of a rational right-angled triangle cannot equal a square.

Solved by Raymond Huck, Johnston City, Ill.

Any unequal rational values substituted from m and n in the expressions representing the sides of the rational right-angled triangle, will yield a rational area. The area of this triangle is

$$mn\ (m+n)\ (m-n),$$

an expression which can never represent a rational square.

Also solved by *Louis R. Chase, Newport, R. I.*

1120. *Proposed by William Bashfield, Walla Walla, Wash.*

The problem as stated is meaningless. An error has been made evidently in giving the data.

PROBLEMS FOR SOLUTION.

1133. *Proposed by Mildred E. Collins, Newburyport, Mass.*

What is the value of the dihedral angle of a regular tetrahedron? Can this problem be solved without the use of trigonometry?

1134. *Proposed by Louis R. Chase, Newport, R. I.*

Find the whole numbers whose digits from left to right are a, b, c, d, each of which is greater than unity, and satisfy the following equations: (1) $a^2+2bc+d^2=77$ and (2) $b+c=2\ ad$.

1135. *Proposed by W. E. Buker, Leetsdale, Pa.*

(Taken from College Geometry, Altshiller-Court).

If in a triangle ABC the lines BM, CN intersect on the altitude AD, then AD is the bisector of the angle MDN.

1136. *Proposed by A. A. Shaw, University of Arizona.*

Prove that the product of any three consecutive integers is a multiple of 504 if the middle integer is a perfect cube.

1137. *Proposed by Norman Anning, University of Michigan.*

Find integers n and r such that ${}_nC_{r-1}$, ${}_nC_r$, and ${}_nC_{r+1}$ shall be in arithmetical progression.

1138. *Proposed by R. T. McGregor, Elk Grove, Calif.*

A quadrilateral is inscribed on one circle and circumscribed about another. Show that the straight lines joining opposite points of contact of the in-circle are at right angles.

BOOKS RECEIVED.

Algebra for Junior and Senior High Schools by J. W. Calhoun, Professor of Applied Mathematics, University of Texas, E. V. White, Professor of Mathematics, Texas State College for Women and T. McN. Simpson, Jr., Professor of Mathematics, Randolph-Macon College. Cloth. Pages xi+485. 13x9 cm. 1930. Johnson Publishing Company, 8-10 South Fifth Street, Richmond, Virginia. Price $1.40.

Genetics an Introduction to the Study of Heredity by Herbert Eugene Walter, Professor of Biology, Brown University. Third Edi-

Instructional Tests

in Chemistry in Physics in Biology

These are scientifically made instructional tests carefully developed to cover the essentials of any first course in these three important subjects. They are Glenn-Welton's Instructional Tests in Chemistry, Glenn-Obourn's Instructional Tests in Physics, and Blaisdell's Instructional Tests in Biology. Each of the tests consists of a series of unit tests to be given at intervals throughout the year to insure mastery of fundamentals. This is the up-to-date testing and drill which reduces to a minimum the chance of discovery at the end of a course, when it is too late, that many students are lacking in certain fundamentals and specific skills.

Send for complete descriptions

WORLD BOOK COMPANY

Yonkers-on-Hudson, New York 2126 Prairie Ave., Chicago

New Work Books in Mathematics

A Work and Test Book in Plane Geometry

by

GOFF—MIRICK—MULLINS

List Price $0.36

Ninety exercises and tests furnishing drill and remedial work in plane geometry. Special emphasis is placed on short questions with the purpose of covering a wide range of subject matter.

A Work and Test Book in Elementary Algebra

by

GOFF—MIRICK

List Price $0.60

A workbook containing one hundred eighteen tests and remedial exercises for first year algebra classes.

Briefer Course—A Work and Test Book in Elementary Algebra

by

GOFF—MIRICK

List Price $0.28

A briefer course of the above book containing ninety tests and exercises for first year algebra classes.

A growing list of progressive schools are already using these books.

Write for examination copies

ROW, PETERSON AND COMPANY

EVANSTON, ILLINOIS

144 W. 22nd St. New York City — **1931 Cherry St. Philadelphia** — **149 New Montgomery St. San Francisco**

tion. Cloth. Pages xxi+359. 12.5x19 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $2.50.

Projective Geometry by John Wesley Young. Pages ix+185. 13.5x19.5 cm. 1930. The Open Court Publishing Company, 337 East Chicago Avenue, Chicago, Illinois. Price $2.00.

Studies in the Theory of Numbers by Leonard Eugene Dickson, Professor of Mathematics in the University of Chicago. Cloth. Pages x+230. 17x25 cm. 1930. The University of Chicago Press, Chicago, Illinois. Price $4.00.

Arithmetic of Electricity by T. O'Conor Sloane, Author of Standard Electrical Dictionary, Electricity Simplified, etc. Cloth. Pages ix+230. 12.5x18 cm. 1930. The Norman W. Henley Publishing Company, 2 West 45th Street, New York. Price $1.50.

General Chemistry by Harry N. Holmes, Professor of Chemistry in Oberlin College. Revised Edition. Cloth. Pages x+654. 14x21.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $3.50.

Science in the Service of Health by Elliot R. Downing, Associate Professor of the Teaching of Science, The University of Chicago School of Education, Chicago, Illinois. Cloth. Pages vii+320. 13.5x19.5 cm. 1930. Longmans, Green and Company, 55 Fifth Avenue, New York. Price $2.00.

Differential Geometry of Three Dimensions by C. E. Weatherburn, Professor of Mathematics in the University of Western Australia. Volume II. Cloth. Pages xii+239. 13.5x22 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $4.25.

Progressive Business Arithmetic An Introductory Course by William L. Schaaf, Department of Mathematics, Preparatory High School, College of the City of New York. Cloth. Pages vii+439. 13.5x19.5 cm. 1930. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price $1.44.

The Radio Amateur's Handbook by A. Frederick Collins, Inventor of the Wireless Telephone 1899. Revised and reset (1930). Edited by George C. Baxter Rowe, formerly of the Radio News. Cloth. Pages xxv+368. 13.5x20 cm. Thomas Y. Crowell Company, New York. Price $2.00.

Practical Chemistry by Newton Henry Black, Assistant Professor of Education, Harvard University and James Bryant Conant, Professor of Chemistry, Harvard University. Revised Edition. Cloth. Pages x+522. 12.5x19 cm. 1929. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.25.

Applied Business Arithmetic by Charles E. Steele, Vocational Department, Seattle Public Schools, Seattle, Washington and George W. Muench, Industrial Arts Department, Broadway High School, Seattle, Washington. Pad form, printed on one side of sheets 8x10.5 inches. 40 Lessons. 1930. World Book Company, Yonkers-on-Hudson, New York. Price 80 cents.

My Work Book in General Science by Ellis C. Persing, Department of Biology and General Science, School of Education of Western Reserve University and Kimber M. Persing, Department of Science, Glenville High School, Cleveland, Ohio. Paper. 128 pages. 21x27 cm. 1927. The Harter School Supply Company, 2046 East Seventy-First Street, Cleveland, Ohio.

Astronomy by Robert H. Baker, Professor of Astronomy in the University of Illinois. Cloth. Pages xix+521. 15x23 cm. 1930. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Price $3.75.

Differential Equations by Forest Ray Moulton, PhD. Sc.D. Cloth. Pages xv+395. 14x21.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $5.50.

Practical Mathematics Part I Arithmetic with Applications by Claude Irwin Palmer, Professor of Mathematics and Dean of Stu-

AN INTRODUCTION TO BIOLOGY

Alfred C. Kinsey

A unit study of the science of life, in which the emphasis is placed upon phenomena common to both plants and animals. General principles are illustrated by specific instances; data derived mostly from original sources. Accompanying **Field and Laboratory Manual** gives large number of exercises, providing for selection according to class needs.

PLANE GEOMETRY

Warren R. Good

Hope H. Chipman

A thoroughly modern text, which aims to make the study of geometry attractive. Has been successfully tested in class use with pupils of varying ability levels.

J. B. LIPPINCOTT COMPANY, 1249-57 South Wabash Avenue, Chicago

SOMETHING DIFFERENT

If you are looking for a book that's different—both useful and entertaining—you are looking for the 1930 edition of

"Mathematical Wrinkles"

This revised and enlarged edition is now ready for shipment. Various new helps have been included.

This beautiful volume contains everything necessary for the Mathematics Club—required by either teacher or student. It is a handbook of mathematics and should be in every library.

(An Ideal Xmas Gift for teacher or student)

"This book ought to be in the library of every teacher."—*The American Mathematical Monthly, Springfield, Mo.*

"A most useful handbook for mathematics teachers."—*School Science and Mathematics, Chicago, Ill.*

"A most convenient handbook whose resources are practically inexhaustible." "We cordially recommend the volume as the most elaborate, ingenious and entertaining book of its kind that it has ever been our good fortune to examine."—*Education, Boston, Mass.*

"An exceedingly valuable Mathematical Work." "Novel, amusing and instructive." "We have seen nothing for a long time so ingenious and entertaining as this valuable work."—*The Schoolmaster, London, England.*

Forward your order today .... **Price $3.00 Postpaid**

(Two copies if ordered direct $5.50)

Samuel I. Jones, *Publisher*

LIFE AND CASUALTY BLDG. NASHVILLE, TENN.

Please mention School Science and Mathematics when answering Advertisements.

dents, Armour Institute of Technology. Third Edition. Cloth. Pages x+165. 11x17 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $1.25.

The Use of the Microscope by John Belling, Cytologist, Carnegie Institution of Washington. First Edition. Cloth. Pages xi+315. 14x23 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York.

Practical Mathematics Part II Algebra with Applications by Claude Irwin Palmer, Professor of Mathematics and Dean of Students, Armour Institute of Technology. Third Edition. Cloth. Pages xii+206. 11x17 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York, N. Y. Price $1.25.

New Frontiers of Physics by Paul R. Heyl, Physicist, U. S. Bureau of Standards. Cloth. Pages vii+170. 12.5x19 cm. 1930. D. Appleton and Company 44 Hewes Street, Brooklyn, New York. Price $2.00.

A Laboratory Manual of Qualitative Analysis by Frederick W. Miller, Assistant Professor of Chemistry, New York University. Cloth. Pages xiii+233. 13x20 cm. 1930. The Century Company, 353 Fourth Avenue, New York. Price $2.00.

Statistical Résumé of The Spearman Two-factor Theory by Karl J. Holzinger, University of Chicago. Paper. 43 pages. 21x27.5 cm. 1930. The University of Chicago Press, Chicago, Illinois. Price 75 cents.

The Aryabhatiya of Aryabhata an Ancient Indian Work on Mathematics and Astronomy. Translated with notes by Walter Eugene Clark, Professor of Sanskrit in Harvard University. Cloth. Pages xxix+90. 13x19.5 cm. 1930. The University of Chicago Press, Chicago, Illinois. Price $2.50.

General Chemistry for Colleges by B. Smith Hopkins, Professor of Inorganic Chemistry in the University of Illinois. Cloth. Pages x+757. 13.5x21.5 cm. 1930. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price $3.72.

Problems in General Science by George W. Hunter, Lecturer in Methods of Education in Science, The Claremont Colleges, in California, and Walter G. Whitman, Department of Physical Science, State Normal School, Salem, Massachusetts. Cloth. Pages xii+638. 13.5x20 cm. 1930. American Book Company, 330 East 22nd Street, Chicago, Illinois. Price $1.72.

Reports on Europeon Education by John Griscom, Victor Cousin and Calvin E. Stowe. Edited by Edgar W. Knight, Professor of Education, University of North Carolina. Cloth. 319 pages. 12.5x19 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $2.25.

A General Science Workbook by Charles H. Lake, First Assistant Superintendent of Schools, Cleveland, Ohio, Louis E. Welton, Assistant Principal and Head of Science Department, John Hay High School, Cleveland, Ohio, and James C. Adell, Teacher of Science, John Hay High School, Cleveland, Ohio. Paper. Pages vi+346. 18.5x26 cm. 1930. Silver, Burdett and Company, 221 East Twentieth Street, Chicago, Illinois. Price $1.05.

Dietetics for High Schools, A Textbook in Nutrition and Food Economics by Florence Willard, Chairman of the Department of Home Economics, Washington Irving High School, New York and Lucy H. Gillett, Superintendent of the Nutrition Bureau, New York. Revised Edition. Cloth. Pages xxv+290. 12.5x19 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.40.

Exercises and Tests in Algebra through Quadratics by David Eugene Smith, William David Reeve and Edward Longworth Morss. Paper. 127 tests. 19.5x24.5 cm. 1930. Ginn and Company, 15 Ashburton Place, Boston. Price 40 cents.

The Eighteenth Century Revolution in Science—The First Phase by Andred Norman Meldrum. Paper. 60 pages. 16.5x25 cm. 1929. Longmans Green and Company Limited, 53 Nicol Road, Bombay, India. Price 4s 6d. or Rs. 3/-.

Outlines of Sociology by John Lewis Gillin, Professor of Sociology in the University of Wisconsin and Frank W. Blackmar, Professor of Sociology in the University of Kansas. Third Edition. Cloth. Pages x+692. 14x21.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York, N. Y.

The Essentials of Psychology by W. B. Pillsbury, Professor of Psychology, University of Michigan. Third Edition. Cloth. Pages ix+466. 12.5x19. cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York, N. Y.

Manual of Trigonometry for Colleges, Universities and Technical Schools by E. C. Kennedy, University of Texas, College of Mines. Paper. 107 problems and 3 tables. 21x27.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York, N. Y.

Presson Biology Test by John M. Presson, Department of Biology, Girard College under the direction of Le Roy A. King, Professor of Educational Administration and Director, Bureau of Educational Measurements, University of Pennsylvania, Philadelphia. Test 1, Plant Biology; Test 2, Animal and Human Biology. Each test consists of three parts: Part I, 60 completion statements: Part II, 40 multiple-response questions: Part III, 15 matching items. There are two Forms (A and B) of each test. 8 pages each. Package of 25 copies of either form of each test with directions, key and class record, $1.20 per package. Sample copies for examination 30 cents.

Properties and Numerical Relationships of the Common Elements and Compounds by J. E. Belcher and J. C. Colbert, Assistant Professors of Chemistry in the University of Oklahoma. Paper. Pages xii+160. 21x27 cm. 1930. The Century Company, 353 Fourth Avenue, New York, N. Y. Price $1.75.

Everyday Arithmetic for Printers by John E. Mansfield, Head of the Department of Printing, Wentworth Institute, Boston. Second Edition Revised and Enlarged. Cloth. 131 pages. 13.5x20.5 cm. 1930. McGraw-Hill Book Company, 370 Seventh Avenue, New York. Price $1.50.

Electricity for Beginners by Edward Harper Thomas, Author of Forty Elementary Lessons in Electricity. Second Revised and Enlarged Edition with 28 original drawings. Cloth. Pages xxiv+172+26. 10.5x17 cm. 1930. The Norman W. Henley Publishing Company, 2 West 45th Street, New York. Price $1.50.

The Teaching of Secondary Mathematics by Jasper O. Hassler, Professor of Mathematics, University of Oklahoma and Rolland R. Smith, Head of Department of Mathematics, Central High School, Springfield, Massachusetts and Edited by Earle Raymond Hedrick. Cloth. Pages xi+405. 12x19 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $2.50.

Manual of Biology by George A. Baitsell, Professor of Biology in Yale University. Fourth Edition. Cloth. Pages xiv+369. 14x21.5 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $2.60.

Solid Geometry by Rolland R. Smith, Head of Mathematics Department, Central High School, Springfield, Massachusetts, and Leland W. Smith, Teacher of Mathematics, Central High School, Springfield, Massachusetts. Cloth. Pages vii+238. 12.5x19 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.24.

A Textbook of Modern Physics by Leroy D. Weld, Professor of Physics in Coe College and Frederic Palmer, Professor of Physics in Harvard College. Second Edition, Revised with 485 Illustrations. Cloth. Pages xiii+731. 14x21.5 cm. 1930. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pennsylvania, Price $3.75.

BOOK REVIEWS.

Problems of Science Teaching at the College Level by Archer Willis Hurd, Research Associate Institute of School Experimentation, Teachers College, Columbia University. Pp. xviii plus 195. 23x15 cm. 9 charts, 97 tables. The University of Minnesota Press, Minneapolis, Minn.

This is Volume I of a series of reports of investigations in the teaching of science at the college level, prepared under the supervision of Dean E. M. Freeman of the College of Agriculture, Forestry and Home Economics of the University of Minnesota. Much familiar work has been done in measuring achievements of students and investigating factors related to such achievements, but this work has been done with students in secondary schools. The investigation of teaching at the college level has remained practically an unbroken field. These studies concern themselves specifically with the following problems: (1) Does enlarging the size of the dissecting group from two to four students to a cadaver have any pronounced effect upon individual achievement in the study of human anatomy? (2) What is the effect of substituting some library work for part of the laboratory work upon achievements in physiology? (3) What is the effect of eliminating laboratory work in the study of mechanics? and (4) What effect has the size of the class on individual achievements in physics? While these specific studies and the conclusions arrived at will be of special interest to college teachers of anatomy, physiology and physics, the investigations have a more general and greater value in that they present actual concrete illustrations of techniques useful in educational experimentation.

The critical spirit of the studies is illustrated by the scrutiny given the accepted technique of pairing students for equating groups. This has always been a fundamental technique in studies of this sort. When, however, correlation coefficients were determined between achievements in mechanics, for instance, and the various bases for pairing students—intelligence percentiles, preliminary tests, honor points, chemistry grades, freshman mathematics and freshman English—this significant conclusion startles one, "These findings put in question all experimental studies in which students have been paired for equation of groups." Later comes the necessary warning, "Especially do they (the findings) make it worthless to consider any one student as comparable with another unless achievements over a considerable period are compared and found identical in a great variety of activities." One may wonder how many studies would be reduced to zero reliability if subjected to this criterion of judgment.

A valuable bibliography on educational measurements including books, bulletins and periodicals is appended, listing some 150 sources.

R. B. Z.

Solid Geometry by Roland R. Smith, Head of the Mathematics Department, Central High School, Springfield, Mass., Author of Beginners' Geometry and Leland W. Smith, Teacher of Mathematics, Central High School, Springfield, Mass. Pages vii plus 238. 1930. The Macmillan Company, New York.

This solid geometry text has several excellent features:

1. It is consistent in treatment of theorems, exercises and tests, and pupils will find it readable.
2. The fundamental solid geometry concepts and postulates are developed through a series of graded exercises.
3. "Developmental Exercises" precede, and "Proficiency Exercises" follow each new topic or proposition.
4. Some of the propositions are proved in full as models; in others the proof is suggested or left to the pupil according to its difficulty.
5. The mechanical features of type spacing and drawings are good.

Edna E. Austin.

TRANSPARENT ANATOMICAL SPECIMENS

Small Intestine (Cat)

These exquisite embryological and anatomical specimens, prepared by the Spalteholz method, have excited great admiration wherever demonstrated in our universities, high schools, and museums. The specimens are perfectly transparent and can be viewed either by transmitted or reflected light. Besides making excellent exhibition specimens, they have proved of inestimable value for teaching purposes in Embryology, Physiology and Anatomy, as they show all parts in situ just as they are found in the living animal.

The doubly-injected cat intestine shown in the illustration clearly demonstrates the course of the blood supply to and from this portion of the digestive tract, the arteries being injected with red and the veins with blue injection mass. Examination with a hand lens discloses the minutest capillaries. We feel confident that these preparations will meet with enthusiastic approval.

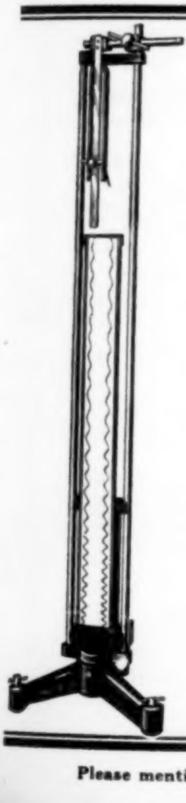
SM 50 Small Intestine (Cat). As described, beautifully prepared in thoroughly sealed rectangular museum jar of best quality, each **$15.00**

Ask for our complete List of Spalteholz Preparations.

NEW YORK BIOLOGICAL SUPPLY CO.

General Supplies for the Biological Sciences

34 Union Square New York, N. Y.



L1005 Acceleration Apparatus

Falling Plate Type

This smaller and simpler type of Acceleration Apparatus has many advantages. The use of the stationary tuning fork and the falling plate permits of a larger amount of drop in proportion to the size of the apparatus. The manipulation is much simpler and surprisingly good results can be obtained by students in elementary classes **$30.00**

L1005a Atwood Attachment for L1005 Acceleration Apparatus, for testing Newton's Second Law of Motion.. **$14.00**

Further details and sample record on request

THE GAERTNER SCIENTIFIC CORPORATION

1201 Wrightwood Avenue Chicago, U. S. A.

Please mention School Science and Mathematics when answering Advertisements.

Poetry and Mathematics, by Scott Buchanan, Associate Professor of Philosophy, University of Virginia. 14.5x19.5 cm. 197 pages. 1929. New York. The John Day Company. Price $2.50.

Under the title, Poetry and Mathematics, Professor Buchanan presents a philosophical discussion of science and literature. He takes the reader behind the screen of symbols to the things for which they stand.

"Mathematics is not what most teachers of mathematics teach. They, with the good intention of conveying what they themselves have only as a skill of manipulation, have unconsciously worked hocus-pocus on their pupils." "The structures with which mathematics deals are more like lace, the leaves of trees, and the play of light and shadow on a window or a human face than they are like buildings and machines, the least of their representatives."

There are eight chapters viz.:

I—Poetry, II—Figures, III—Numbers, IV—Proportions, V—Equations, VI—Functions, VII—Symbols, VIII—Tragedy and Comedy.

The book is delightfully written. A copy should be placed on the book shelf for repeated reading. J. M. Kinney.

A Short History of Mathematics, by Vera Sanford, School of Education, Western Reserve University, with an Introduction by David Eugene Smith. Cloth. Pages vi+402. 14.5x20.5 cm. 1930. Houghton, Mifflin Company, 2 Park Street, Boston. Price $3.25.

In this Short History teachers of elementary mathematics, that is, mathematics up to and including the calculus, have a delightfully written story of the long struggle of man to comprehend the quantitative character of his environment. There are fourteen chapters with the following headings: I—Men Who Made Mathematics; II—Arithmetic; III—Commercial Mathematics; IV—Algebra; V—Verbal Problems; VI—Practical Geometry; VII—Demonstrative Geometry; VIII—Trigonometry; IX—Analytic Geometry; X—Calculus; XI—Theory of Numbers; XII—Calculating Devices; XIII—Weights and Measures; XIV—The Place of Mathematics in the School Curriculum.

There are 113 illustrations consisting of portraits of mathematicians, mathematical instruments, maps, ancient tablets and manuscripts, and diagrams.

Every teacher of mathematics should have some knowledge of the development of his subject, in order that he may realize the fact that it has been and is a growing subject. In this book he may find that topics and methods which served in the past now serve no useful purpose. Every teacher of elementary mathematics should have a copy in his library. J. M. Kinney.

Analytic Geometry, by David Raymond Curtiss and Elton James Moulton, Professors of Mathematics, Northwestern University. Pages xiii+338. 14.5x20.5 cm. 1930. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price $2.48.

This book includes sufficient material for a three hour course extending through a period of two semesters. It is so organized that shorter courses may be provided. An abundance of material for superior students is included.

The text is written in an attractive style. Discussions and proofs seem to be sufficiently complete so that students may read them with understanding. A special effort has been made to have the student feel the close relationship that exists between analytic geometry, algebra and trigonometry.

Thus, the first chapter deals with the plotting of curves in both Cartesian and polar coordinates. A fuller treatment is presented in Chapter VIII. An unusually good treatment of curve filling is found in Chapter XIII. More space is devoted to solid geometry than we find in the average text. J. M. Kinney.

The Sixth Grade Graduate

has been taught the elements of arithmetic and has developed a definite skill in their application. He enters Junior High School for a three-year period of training in mathematics, for which well-defined objectives have been set up. These objectives require that the teacher weave the arithmetical skill naturally and in an interesting and meaningful way into the beginnings of algebra and geometry, and into the solution of the simplest everyday problems of business.

MODERN JUNIOR MATHEMATICS

By Marie Gugle

Assistant Superintendent of Schools
Columbus, Ohio

offers a three-year program that satisfies Junior High School objectives. Its program, year by year—

SEVENTH YEAR—BOOK ONE

Trains the pupil in the simplest application of arithmetic to business—Develops skill in rapid calculation—Develops the habit of checking—Encourages thrift by making of budgets, etc.—Trains the pupil in the simplest elements of bookkeeping.

EIGHTH YEAR—BOOK TWO

Gives the pupil practical applications in mensuration—Trains the hand to use simple drawing instruments—Familiarizes the pupil with common geometric forms and terms—Introduces algebraic expressions in a natural way.

NINTH YEAR—BOOK THREE

Extends the pupil's knowledge of algebra to negative expressions—Makes the equation so familiar that he uses it naturally as a convenient tool—Enables him to make and interpret formulas—Gives him a glimpse into trigonometry and the labor-saving device in logarithms.

MODERN JUNIOR MATHEMATICS

Book One (for seventh grade) 80c
Book Two (for eighth grade) 90c
Book Three (for ninth grade) $1.00

Place your order with our nearest office
Liberal discounts to schools

THE GREGG PUBLISHING COMPANY

New York Chicago Boston San Francisco Toronto London

Please mention School Science and Mathematics when answering Advertisements.

Practical Mathematics, by Claude Irwin Palmer, Professor of Mathematics and Dean of Students, Armour Institute of Technology. pp. xii plus 206. 12x17.5x2 cm. Third Edition. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York.

"Algebra With Applications" is the title of this book, being Part II of a series of four, the first of which has been reviewed in another report. As in Part 1, the motif of Part II is, "direct applications to practical problems." The material is so devised and arranged that considerable practice is given in the fundamental operations, factoring, fractions, equations and formulas. Graphical methods are given later in a separate chapter, although some applications are made earlier. Numerous problems involving the sciences are found, chiefly those in physics and mechanics, although they are not technical. Answers to the problem are located in the back part of the book.

The book is interesting, worthwhile and useful.

Joseph J. Urbancek.

Algebra, by J. W. Calhoun, Professor of Applied Mathematics, University of Texas, and E. V. White, Professor of Mathematics, Texas State College for Women, and T. McN. Simpson, Jr., Professor of Mathematics, Randolph-Macon College. Pp. xii plus 485. 14x19.2x2.5 cm. 1930. Johnson Publishing Company, Chicago. Price $1.40.

The contents of this book are designed for Junior and Senior High School students, containing enough material for a two-year course. Arrangements for individual differences have been made by supplying numerous exercises and problems permitting selection and relative degrees of advancement. It is adapted to meet the requirements of students who will not go to college and those who will.

The mode of attack is from the concrete to the abstract and the approach is simple and at times almost informal while the process of evolving the algebraic principles goes smoothly on. Where needed, numerical examples are used preceding or accompanying literal problems and quite deftly illustrate the principles involved. Simple geometrical and physical formulas have been used but they do not call for a technical knowledge of geometry or physics. In glancing through the book one finds chapter reviews and summaries serving to refreshen and unify the ideas studied.

Graphs are treated in a separate chapter. The simpler graphs—picture, bar, circle and line, are introduced earlier.

Numerical trigonometry is introduced in one chapter to carry forward the idea of ratio but "may be omitted, if desirable, without in any way breaking the continuity of the course," so state the authors.

The mechanics of the book may be described as clear, open face type, not crowded. A very neat looking book in green fabrikoid stamped in gold.

It is comprehensive, thorough, and well worth having.

Joseph J. Urbancek.

Wonder Flights of Long Ago by Mary Elizabeth Barry and Paul R. Hanna of Lincoln School, Teachers College, Columbia University. Cloth. Pages vii+219. 12.5x19 cm. 1930. D. Appleton and Company, 35 West 32nd Street, New York. Price $1.00.

This book consists of eleven old flying myths well retold, including The Magic Carpet, The Flying Trunk, Phaeton, and others. At first one is inclined to ask "What has this book to do with science?" For the answer read the "Suggestions that may interest you" in the last few pages of the book. Pegasus flew a thousand miles a day; how about Lindy? The Fire-Bird was mistaken for a meteor; here is a door to astronomy. Each story interests the child; much place geography may be learned incidentally. For centuries men dreamed these dreams of flying, then came the Montgolfiers, the Wrights and Count Zeppelin. It is only a step from dream to reality. G. W. W.

THE *PROMI* MICROSCOPIC DRAWING AND PROJECTION APPARATUS

Projects microscopic slides and living organisms and insects on table or wall for drawing and demonstration. Also used as a microscope and a microphotographic apparatus.

The Promi, recently perfected by a prominent German microscope works, is an ingenious yet simple apparatus which fills a long felt want in scientific instruction and research in Bacteriology, Botany, Zoology, Pathology, Anatomy, Embryology, Histology, Chemistry, etc.

It has been endorsed by many leading scientists and instructors.

The Promi apparatus is simple to set up and easy to manipulate. It swings easily from vertical to horizontal position on a swivel rod. The light source is enclosed in a metal housing and the proper adjustment of both light and condenser is facilitated by use of swivel and sliding joints. The object stage is hollow for continual water cooling. Ocular and tube are furnished for high power magnification, and both objectives and eye pieces are of the standard microscope type. Rheostat can be used with both AC and DC current and for both 110 and 220 volts. Special constructed tank makes possible projection of living organisms in fluid. As a drawing apparatus it can be used in the ordinary lighted classroom for low power work. For drawing purposes in a dim room its magnification ranges up to 200 times and for projection up to 1400 times at a distance of 6 feet.

AS A PROJECTION APPARATUS: Makes it possible for a group of students to examine a single specimen simultaneously. Invaluable for instructors in focusing students' attention on important features, which cannot be demonstrated with equal facility and time saving under a microscope. Eliminates the eye strains of microscope examination.

AS A DRAWING LAMP: The illustration shows how a microscopic specimen slide is projected on drawing paper enabling student or teacher to draw the image in precise detail. Living insects or microscopic living organisms can also be projected. Higher magnification may be obtained by using tube and ocular and or high power objectives. Charts can really be made for classroom instruction.

AS A MICROSCOPE: The apparatus is easily converted into a compound microscope. Higher magnification is possible by the use of standard microscopic high power objectives and oculars.

AS A MICROPHOTOGRAPHIC APPARATUS: Microscopic preparations of slides, living organisms and insects can be photographed without the use of a camera.

PRICE: F. O. B. New York **$100.00** complete apparatus in polished wood carrying case. Includes extra bulb, rheostat for 110 and 220 volts with cords, plugs and switch for both DC and AC current, 11x objective, tube with 5x ocular, reflecting mirror and tank "microcuvette." Extra equipment prices on request.

Prospectus gladly sent, address

Exclusive Wholesale Distributors

CLAY-ADAMS COMPANY

117-119 East 24th Street
NEW YORK, N. Y.

Progressive Business Arithmetic, by William L. Schaaf, Ph.D., Department of Mathematics, Preparatory High School, College of the City of New York, formerly of the Actuarial Division, Metropolitan Life Insurance Company. Pp. vii plus 439. 14.5x20x2.8 cm. 1930. D. C. Heath and Company, Chicago.

Quoting briefly from the preface we note the following:

"This text is designed for a year's course in modern business arithmetic. It is intended for use in junior high schools, business schools, vocational schools, and many other institutions offering an introductory course in business mathematics or commercial arithmetic."

The mode of development is of the psychological order rather than the older type method, the logical order, and is consistent with modern practices and tendencies in that respect. The material is modern, free of obsolete matter, practical, teachable, and designed for the understanding of the pupil. The author has taken care to adjust the subject matter to meet the requirements of various agencies in order to fulfill a pedagogical dictum. Innumerable facts and principles regarding business and its activities are present. The graph and its uses are made quite clear after a simple and illuminating presentation and development. Geometrical facts and formulas are found with sufficient problems for clarification and retention.

Any child or adult can well profit by the use of this book.

Joseph J. Urbancek.

Handbook of Chemistry and Physics by Charles D. Hodgman, M.S., Associate Professor of Physics at Case School of Applied Science and Norbert A. Lange, Ph.D., Assistant Professor of Organic Chemistry at Case School of Applied Science. Chemical Rubber Publishing Co., Cleveland, Ohio. 1929. xii+1386 pp. 17.3x11.2 cm. Fourteenth Edition Deluxe. Price $5.00.

This well-known reference book is mechanically well put up: its flexible cover and fine paper makes it not only attractive but wonderfully compact. Within a thickness of 4 cm. it covers with great completeness the scientific date of two allied sciences. In addition it carries 155 pages of valuable mathematical tables. It is thoroughly indexed and in its appendix carries 15 blank pages for professional notes. The table of contents presents an imposing number of units, forty-six of which have been revised. Much new material has been added. Important new information is presented on emission spectra, ceramics, barometric conditions, ultra violet and infra red radiation, heat of combustion of organic compounds, gases and coals, constants of resins and gums, thermal expansion and on other topics. Students and teachers in high schools and colleges will find this book exceptionally helpful in their daily work, be it science or mathematics. In libraries as well as in all school and industrial laboratories this new edition should prove very useful as a standard reference.

W. F. Roecker.

Applied Business Arithmetic, by Charles E. Steele, Vocational Department, Seattle Public Schools, Seattle, Washington, and George W. Muench, Industrial Arts Department, Broadway High School, Seattle, Washington. Paper. Pages iv+124. 1930. World Book Company, Yonkers-on-Hudson, New York. Price 80 cents.

One of the most persistent criticisms of arithmetical teaching is that the pupil cannot apply his knowledge. The authors of this text believe that pupils need to be trained in applications, and for this purpose they have prepared an excellent text in a pad form.

The material of the course is divided into forty units consisting of about three pages each, and is intended for a semester course. Since the units may be taken in any order, the test provides a very flexible course which can be made to fit individual needs. It gives practice in computation, but only in connection with concrete data. A few review problems for each set of ten units are given. The

Do You Know

The Powerful Impetus to Instruction Offered by

The Speed-Up Geometry Ruler?

Copyright, 1930, by Edna Leola Dixon, A. M.

It is a Magic Tool

Presenting in a clear transparent sheet of celluloid openings for stencilling all typical figures of plane geometry either directly or by sliding the ruler, and gradations for varying size without altering shape.

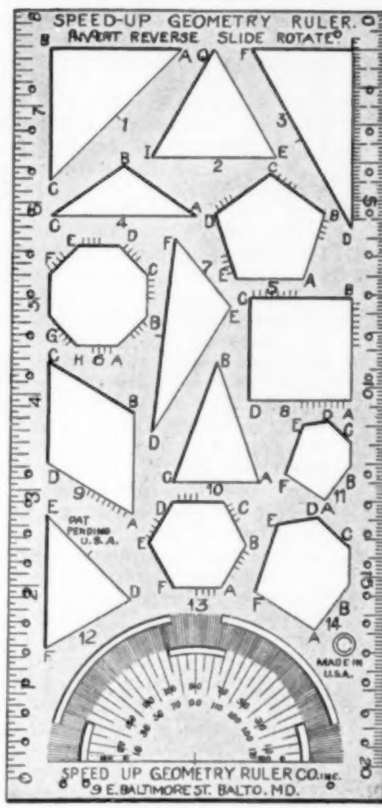
And a Teaching Instrument

Providing uniform means for class procedure, all openings being numbered and vertices lettered.

Being encased in a tie envelope with a pamphlet suggestive as to its uses by students and teachers of both senior and junior high schools.

Already Listed for Use in the Public Schools

of Philadelphia, Boston, and Baltimore, not to mention those of many, many, smaller Communities.



Cut ¼ Size
PATENTS PENDING

ORDER NOW

Either in behalf of your students or for your schools, from

The Speed-Up Geometry Ruler Co., Inc.

9 E. Baltimore St., Baltimore, Md.

ONE DOLLAR LIST PRICE EACH

But in accordance with direct sales program to Schools
25% discount, under a dozen : 35% discount, a dozen or more

business forms are up-to-date, and provide useful experience in business practice, stimulate interest and encourage neatness and accuracy.

Teachers and others interested in business arithmetic should see this unusual text. It ought to prove especially valuable as supplementary work for pupils using other texts. Leora Blair.

Specimen Objective Examinations by G. M. Ruch, Professor of Education, University of California, Berkeley, California, and G. A. Rice, Associate Professor of Education, University of California, Berkeley, California. Cloth. Pages vi+324. 14x21.5 cm. 1930. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Illinois. Price $1.80.

The authors conducted a "nation-wide contest in the construction of objective or new-type examinations." Three hundred seventy-five of the examinations submitted met the conditions and were admitted to the contest. These were classified by school subjects; viz., English, social studies, natural science, home arts, manual arts, mathematics, foreign language, commercial subjects. Three judges for each group scored the papers and awarded first, second and third prizes and honorable mention to the fourth and fifth. The scoring was on the basis of 100 points as follows: Reliability 25, validity 40, ease of administration 10, ease of scoring 10, originality 15.

Analysis of the examinations resulted in recognizing seventeen different types of tests. Of these *completion* and *true-false* made up over half of the tests, and these with *multiple-choice* questions accounted for 70% of all items. Selected illustrations of the principal types are given. These illustrations should be very helpful to teachers who are constructing new-type tests.

Except for the first twenty-two pages the book is made up of the examinations awarded prizes and honorable mention. Answer keys are included. The reviewer directed his attention to those in the fields of mathematics and the natural sciences. In the secondary school field objective testing was applied to mathematics long before a start was made by research workers and teachers in most of the other subjects. These published examinations show the fruits of this long training period. These tests have reached a high stage of perfection and should be suggestive to teachers in other departments. Few criticisms can be made of either the questions or the answers.

The natural science group presents an interesting situation. The three prizes were awarded to chemistry papers, honorable mention to a biology examination and to one in general science. In general the chemistry questions cover all phases of the subject fairly well and are reasonably free from objectionable questions and answers. However, in one list of forty-nine "true, false, and other chemical statements" three errors or doubtful answers are recorded. The biology list is largely factual material; little emphasis is placed on scientific thinking. When the general science list is examined closely we wonder if the judges had about reached the end of available material and what the other sixty-one natural science papers were like. In the published paper we learn that breathing of plants takes place mainly in the roots, that the outside covering of a tooth is dentine, that the water table is always below the surface of the land, that dew falls, that frost is frozen dew, that a lift pump cannot pump water forty feet high, that water is hard when it contains minerals, that air in vertical motion is an air current but when in horizontal motion it is a wind, that storms originating at sea are hurricanes, that a period of clear weather is an anticyclone, that the liver secretes pancreatic juice, that Galileo made the first successful airplane, and other interesting fables.

It is evident that some of these errors are due to careless proof reading—accuracy sacrificed for speed, but many of them are typical of the kind of science found in many elementary science textbooks

Junior-Senior High School Clearing House

Edited by
Forrest E. Long, Philip W. L. Cox, Arthur D. Whitman, William A. Gore and More than Forty Nationally Prominent Educators

The JUNIOR-SENIOR HIGH SCHOOL CLEARING HOUSE is a journal for the progressive junior and senior high school worker. To such it brings discussions by secondary leaders dealing with the paramount problems of the field. Its editorial policy is liberal, its editorial plan sound. Monthly it gathers articles on specific phases of secondary work into a related group easily examined by the school executive and teacher.

The articles in the September issue dealt with the subject "Advisement and Guidance." The October number deals with "Miscellaneous Problems." November will see a discussion of "Athletics," and December the subject "Visual Education." "The Adolescent," "Mathematics," "Creative Arts," "Promotions and Graduations," will be among the subjects for the rest of the year.

More and more the JUNIOR-SENIOR HIGH SCHOOL CLEARING HOUSE is being recognized as the leading journal for secondary people. Executives and teachers alike find in it the inspiration and information they need to keep intelligently modern in their viewpoint.

Subscription—$3.00 per year

**Junior-Senior
High School Clearing House**

**32 Washington Place
New York City**

School Science *and* Mathematics

will keep you in touch with the most recent advances in scientific knowledge and teaching methods.

Classroom helps and special teaching devices for difficult topics are regular features. The Problem Department and Science Questions give inspiration and extra activities for superior students.

The most progressive teachers in secondary schools and colleges all over the world are regular readers and many of them are frequent contributors to this Journal.

School Science and Mathematics
1439 14th Street, Milwaukee, Wis.

HULL BOTANICAL SUPPLY HOUSE

**411 Hancock Street
Gary, Indiana**

New Circular of Living Material

Including Plants and Animals for Aquaria and Terraria, Living Plants for Physiological Experiments, Living Plants for Microscopical Study, etc. We also have a very extensive list of museum preparations in botany, and a considerable stock of preserved botanical material. **Satisfaction guaranteed.**

The Central Association of Science and Mathematics Teachers

A progressive, influential, organization. $2.50 pays your membership and brings you the official journal for one year. Send membership dues to **Ersie S. Martin,** *Treasurer*, Arsenal Technical High School, Indianapolis, Indiana.

and recitations. These tests are not submitted as standardized tests and hence should not be used as such, but they are presented as "worthy of study and imitation by teachers" and in this manner they will be used as textbooks are frequently used, i. e. as being inerrant. So many serious errors have been found in objective tests that have been published that all educational agencies should unite to prevent further mistakes. All tests and answer keys should be minutely examined not only by test construction experts but also by subject matter experts before publication. Everyone in any way connected with the publication of a test such as this general science examination should be held an accessory to the teaching crimes resulting therefrom. G. W. W.

BIRD AND ARBOR DAY.

By W. F. Roecker.

Once a year Bird and Arbor Day is observed in most states. Throughout the year the topic of Conservation is in order. General Science and Biology classes as well as various Clubs and Societies find frequent occasion to discuss birds and trees and our natural resources in general. Aside from Bird and Arbor Day Annuals, which many states publish, the United States Department of Agriculture offers a wealth of published bulletins; many helpful publications can also be obtained from various Nature Associations.

Teachers who desire to secure a supply of source material in this field for Class and Club use should write for the lists suggested below. From these lists the appropriate material for any occasion can be readily selected. Much of it can be obtained free and in any case the cost will be nominal.

United States Department of Agriculture Bureau of Biological Survey, Washington, D. C.

Lists of Helpful Publications

Bulletins:

Bi-159, Publications on attracting birds, bulletins by the U. S. Department of Agriculture, Audubon Societies and others.

Bi-161, Publications of the U. S. Bureau for general distribution, informational leaflets, etc. Birds and Animals.

Bi-922, Some Suggestions for Bird Field Trips: leaflet, one page.

Bi-737, Aids for Bird Students: Publications for free distribution, for sale; popular books for bird identification; general works on birds; ornithological magazines; bird lectures, lantern slides, motion pictures, books on taxidermy, etc.

Associations and Societies which supply literature in the fields of nature study and conservation.

American Tree Association, Washington, D. C.
American Nature Association, Washington, D. C.
American Forestry Association, Washington, D. C.
National Association of Audubon Societies, 1974 Broadway, New York City.

(Other publications will be given in the November issue.)

Give us a man, young or old, high or low, on whom we know we can thoroughly depend—who will stand firm when others fail—the friend faithful and true, the adviser honest and fearless, the adversary just and chivalrous; in such a one there is a fragment of the Rock of Ages—a sign that there has been a prophet among us. —Dean Stanley.